Hydration—More Than Just Water

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A Conversation with Dr. Ann Grandjean

Proper hydration is vital for your health and well-being. But, how do you know how much to drink each day? Or, what actually "counts" towards meeting hydration needs? To answer these questions and to better understand how advances in hydration science can benefit people at every age and stage of life, the Beverage Institute for Health & Wellness (BIHW) of the Coca-Cola Company talked with noted hydration expert Ann Grandjean, EdD, FACSM, CNS.

BIHW: ***Why do we need water?***

Dr. Grandjean: I consider water our most essential nutrient. Most of us can go for weeks or even months without consuming some vitamins and minerals with no ill effects. On the other hand, our bodies lose large amounts of water each day, which must be replaced. We simply cannot survive very long without it. And, the detrimental mental and physical performance effects of negative water balance, or hypohydration, can set in rather quickly.

Water is essential for a myriad of essential bodily functions, including digestive, absorption, circulatory, and excretory functions, as well as the utilization of the water-soluble vitamins. It is required for the transportation of nutrients and waste products in and out of cells, and to make saliva, which helps protect against tooth decay. Water helps cushion joints and plays a major role in maintaining body temperature – among other things.

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BIHW: ***Many people believe that plain drinking water is more hydrating than other beverages. Is this true?***

Dr. Grandjean: No. The belief that drinking water is essential to maintaining hydration status is a common misperception – for example, many frequent travelers have asked me how they can stay hydrated when they don't always have easy access to water. In fact, this premise in part stimulated an interest among my colleagues at The Center for Human Nutrition and me to study whether there is a difference in maintaining hydration status based on the types of beverages consumed.[1]

For our study, healthy volunteers participated in two separate trials, which differed only in the types of beverages consumed. During one trial, one-third of the total fluid volume consumed was plain water and two-thirds was a mix of juice, coffee and soft drinks. We used this mix because it closely represents what most Americans consume. During the other trial, the subjects consumed the same amount of fluid, but the beverage mix included only juice, coffee and soft drinks – no drinking water. Upon analyzing the results, we found no differences in markers of hydration, which suggested that although the body needs water, it doesn't need drinking water per se as long as adequate amounts of other beverages are consumed.

To understand why this is true, it helps to think of "water" as a nutrient your body needs. The nutrient "water" is present in plain drinking water, of course. But, it is also present in other

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fluids like juice, coffee and other beverages—as well as in most foods—in varying amounts. This nutrient "water" is absorbed by the body and acts the same physiologically regardless of its dietary source.

BIHW: ***So, foods contribute water to the body?***

Dr. Grandjean: Correct. People are often surprised that foods contribute water to the body. But, just as there are beverage and food sources of calcium, such as milk, cheese, leafy-green vegetables and almonds, almost everything we eat and drink contains some amount of water that the body can use. For example, it may not be surprising that plain drinking water, tea, coffee, sports drinks, milk, soft drinks, and fruit and vegetable juices are 85 to 100 percent water (solid substances like the calcium and protein in milk and the pulp of juices account for the rest). But, few people realize that cooked rice, pasta, and cereals are between 65 to 90 percent water, and that even nuts are one to 5 percent water by weight.[2]

In fact, according to the Institute of Medicine (IOM), of the total amount of water consumed by the average American, about 20 percent comes from food and 80 percent comes from drinking water and other beverages.[3] Of course, this varies considerably from person to person. Those who eat a lot of soup, stews, sauces, salads and fruit tend to obtain more than 20 percent of their total daily water from foods, while those whose diets tend to be dry—who eat more breads, crackers and well-done meats—may get less than 20 percent of their total daily water from foods.

Water Content of Selected Foods and Beverages

FOOD/BEVERAGE	% WATER
Water, brewed tea, brewed coffee, diet soft drinks, canned/bottled tea, sports drinks, lemonade, vegetable juice	90% to 100%
Milk, soft drinks (regular), fruit juice, fruit drinks	85% to 90%
Most fruits and vegetables	70% to 85%
Cheese	40% to 50%
Cooked cereals, rice and pasta Breads, bagels, biscuits Ready-to-eat breakfast cereals	65% to 90% 30% to 45% 2% to 5%
Fish and seafood Beef, chicken, lamb, pork, turkey, veal	70% to 80% 45% to 65%
Chips, pretzels, candies, crackers, puffs, dried fruit, popcorn	1% to 10%
Seeds and nuts	1% to 5%

Source: Hydration: Fluids For Life (ILSI 2004)

BIHW: ***Are there specific factors that drive fluid consumption in humans?***

Dr. Grandjean: Yes. The primary physiological driver for fluid consumption is thirst, which in turn has three main physiologic triggers. Two of those triggers, cerebral osmoreceptors and extracerebral osmoreceptors, respond to intracellular dehydration, while volume receptors respond to extracellular dehydration, which is closely tied to blood volume. Water in the body is found primarily in two distinct compartments: intracellular fluid serves primarily as a medium for cellular metabolism; extracellular fluid primarily carries nutrients and oxygen to cells and metabolic waste products away from cells via the bloodstream. Although water does flow between these two compartments, when either of these gets too low, thirst is triggered. For most healthy people, a loss of body fluids equal to about one percent of body weight triggers thirst.

However, beverage choice is as much, if not more, a behavior as a response to thirst. For example, culture has a major influence on food and beverage preferences. The British are known for drinking tea; the Italians, wine. And, there are other factors that affect beverage choice, such as sensory attributes that affect palatability—like color, flavor, odor and texture—as well as appearance, temperature and availability.

BIHW: ***Probably the most surprising development about hydration is the scientific consensus by the Institute of Medicine (IOM) that caffeinated beverages are not dehydrating as previously thought. How did scientists reach this conclusion?***

Dr. Grandjean: Good question. While older studies showed a diuretic effect from consuming caffeine, either in pill form or as caffeinated beverages, they used certain conditions that reflect only how caffeine and caffeinated beverages affect individuals who completely avoid caffeine.[4,5,6] As a result, these studies did not really tell us whether habitually consuming caffeinated beverages in normal amounts and patterns—typical of "real life" caffeine consumers—causes dehydration. But, many people erroneously assumed this was the case.

However, for the IOM's 2004 Dietary Reference Intakes (DRI) report on water needs, hydration experts reviewed the existing peer-reviewed scientific literature related to caffeine and hydration, including a number of studies published within the past decade that examined the effects of caffeine on the hydration status of individuals who routinely consume caffeinated beverages. These experts determined that compared to other beverages, coffee, tea, and other caffeine-containing beverages do not negatively affect indicators of hydration in those accustomed to consuming caffeine.[3]

BIHW: ***How much water do we need each day for proper hydration?***

Dr. Grandjean: Hydration is a frequently-used term. However, it is more precise to use terms that define the state of hydration. [See Key Definitions] The goal is to be in a state of water balance, or euhydration. Water requirements are determined by an individual's metabolism, environmental conditions, and activity level, and are therefore extremely variable. Not only do requirements vary from individual to individual, they can vary greatly for a given individual from day to day.

So the short answer is that it depends, although in 2004 the IOM gave us some general guidelines for total daily water consumption, which include food and beverage sources. These guidelines are for healthy, sedentary people living in moderate climates; active people or

those exposed to high temperatures, high altitudes or very low humidity could need more.

Recommended Water Intakes for Individuals (AI)

AGE RANGE	DAILY WATER ADEQUATE INTAKE	
	Total Water*	Amount from beverages, including drinking water
Infants		
0 – 6 months	3 cups (0.7L)**	
7 – 12 months	3.5 cups (0.8L)***	
Children		
1-3 years	5.5 cups (1.3L)	4 cups (0.9L)
4-8 years	7.5 cups (1.7L)	5 cups (1.2L)
Adolescents, 9-13 years		
Males	10.5 cups (2.4L)	8 cups (1.8L)
Females	9 cups (2.1L)	7 cups (1.6L)
Adolescents, 14-18 years		
Males	14 cups (3.3L)	11 cups (2.6L)
Females	10 cups (2.3L)	8 cups (1.8L)
Adults. 19-70+		
Males	16 cups (3.7L)	13 cups (3L)
Females	11.5 cups (2.7L)	9 cups (2.2L)

*"Total water" includes fluids from all foods and beverages consumed. Rounded up to the nearest 1/2 cup.
**assumed to be from human milk.
*** assumed to be from human milk and complementary foods and beverages.
Source: Institute of Medicine of the National Academies of Sciences 2004.

BIHW: ***How can individuals assess their hydration status?***

Dr. Grandjean: The "gold standard" for determining hydration status at a specific point in time is to test the blood for serum osmolality. However, taking a blood test is not convenient or desirable for most people, so we usually do so only under clinical conditions or during research studies.

For most athletes and healthy individuals, monitoring urine color is a reasonable method to determine if they are drinking enough fluids. Urine with a "light straw" or pale yellow color suggests adequate hydration. Urine that is dark in color suggests one is not drinking enough, although some medications and vitamin supplements can affect urine color. Frequency of urination is another indicator. Healthy individuals should be able to urinate at least four times a day. For athletes, day-to-day body weight change is an accurate estimate of hydration changes, provided that careful baseline measures are obtained and there is control for confounding factors, as is pre- and post-exercise body weight change, assuming exercise began in a state of euhydration.[7]

And, of course, thirst should not be ignored. However, while thirst is a biological signal that your body is in negative water balance and needs more fluids, lack of thirst may not always be an accurate indicator of adequate fluid intake.

BIHW: ***Who is most at risk for inadequate fluid intake?***

Dr. Grandjean: Those at increased risk for inadequate fluid intake include infants, the elderly, and people who live or work in hot environments or who are physically active.

Infants: Infants differ physically and physiologically from adults and children. For example, a higher percentage of an infant's body weight is water. An infant's fluid exchange rate is also seven times greater than that of an adult, and their metabolic rate is two times greater relative to body weight.[2] As a result, an infant can dehydrate very rapidly.

Elderly: Although the body system responsible for regulating water loss via the kidneys, and thus the ability to conserve body water, appears to be less robust in the elderly, the issue of dehydration in the elderly appears more related to input than output. Age-associated physiologic changes, including thirst impairment, incontinence, reduced mobility and confusion, can limit voluntary fluid intake, particularly among institutionalized elderly and frail older adults in the community. For these individuals, poor hydration can have significant consequences. Dehydration in the elderly is associated with increased risk of falls, urinary tract infections, dental disease, bronchopulmonary disorders, kidney stones, cancer, constipation, and impaired cognitive function.[2] However, healthy elderly are generally able to maintain fluid balance by responding to their thirst.

Physical activity and hot environments: The DRIs for water are intended for inactive to moderately active people living in mild environments; those who are physically active or exposed to hot environments need more—sometimes much more. The daily water requirements for temperate conditions can double or even triple in very hot weather and can quadruple for very active individuals compared to those who are sedentary.[8] The words "physically active" often conjure up visions of athletes, but people who work as farmers, miners, military personnel, construction workers, fire fighters, miners, forest workers, park and recreation employees, and industrial personnel are often highly physically active, and in many cases, work in hot environments.

BIHW: ***Can someone consume too much fluid?***

Dr. Grandjean: Yes. Fortunately, it's an uncommon occurrence, but it can happen. If we drink more fluid than we need, our body increases urine output in proportion to the excess fluid intake. If the amount of fluid exceeds our kidney's ability to excrete the excess water, the concentration of sodium in our body becomes diluted, which can lead to a serious electrolyte imbalance. This imbalance is often called hyponatremia or water toxicity. The medical terms for this condition are hypotonic dehydration, hyponatremic dehydration, and volume and electrolyte depletion. We most commonly see hyponatremia in infants less than six months of age. Water intoxication can also occur in infants who drink several bottles of water a day or infant formula

that is too dilute. More recently, the condition was documented as occurring in athletes and called "Exercise-Associated Hyponatremia (EAH)".[9] Some medical conditions also can lead to hyponatremia.

BIHW: ***Can dehydration affect cognitive status?***

Dr. Grandjean: Yes. Dehydration can negatively affect cognitive function and motor control.[3] However, most of this research evaluated individuals who were dehydrated due to physical exertion, hot climate, or a combination of the two. Few studies have actually looked at the effects of dehydration resulting from inadequate fluid consumption alone.

We recently conducted two studies in 19- to 35-year-old healthy males to determine if hydration status alone affected cognition. Our results showed that when the subjects were in negative water balance, they took longer to process information. They also experienced reduced psychomotor speed in their dominant hand. These findings, together with other studies that have shown impairments to peripheral vision, perceptive discrimination, tracking, recall, attention, psychomotor skills, and short-term and working memory, suggest that inadequate fluid consumption—either by itself or combined with other stresses—does indeed affect cognition negatively. However, more work needs to be done in this area.

BIHW: ***What else is on the forefront of hydration research?***

Dr. Grandjean: We know dehydration is a problem for the elderly and impairs the performance of athletes. However, there is much more to learn. As mentioned earlier, we are seeing exciting new work examining the effect of hydration status on a healthy individual's ability to perform tasks and concentrate. We also need to understand better the effects of body water deficits on the risk of accidents and on heat stroke or cardiac arrest associated with intense physical activity. We also need to develop non- or minimally-invasive methods to determine hydration status, as well as capabilities to determine fluid needs more precisely.

There is a lot happening in this research arena and a lot more to learn, so stay tuned as the science behind hydration continues to evolve.

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Key Definitions

Beverage

A potable liquid such as water, coffee, tea, soft drinks, milk, fruit juice or vegetable juice.

Dehydration

The process of losing water from the body.

Euhydration

The state of being in water balance, which is the net result of balance between water intake and water loss.

Fluid

Body fluid is a water-based liquid that contains the ions and cells. Dietary fluid includes the liquids consumed from foods and beverages in the diet.

Hypohydration

The state of being in negative water balance.

Hyperhydration

The state of being in positive water balance.

Rehydration

The process of gaining body water.

Total body water (TBW)

The amount of water in the human body.

Total water intake

Water consumed from food and beverages, including drinking water.

Water

An essential nutrient that is a major constituent of all living matter.

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