Guidelines for Adequate Water Intake : A Public Health Rationale

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Over the past years, the European Food Safety Authority (EFSA) has issued two important scientific opinions related to Water. In March 2010, EFSA released its Scientific Opinion on Dietary Reference Values for Water, and in April 2011 EFSA released its Scientific Opinion on water related health claims.

These Scientific opinions were based on an extensive review of scientific evidence. They are extremely important because they clarify the reference values for water among the population in Europe according to age or physiological status (Table1) and confirm the importance of water for the maintenance of basic physiological functions such as thermoregulation, physical and cognitive function. To put it simply, they highlight the importance of drinking enough water (2 litres per day from food and drink) to allow our body to perform optimally.

Table 1. Dietary Reference Values for water EFSA (2010)

			Total water adequate intake
Infants	0-6 months		680 mL/d (trough milk)
	6-12 months		800-1000 mL/d
Children	1-2 years		1100-1200 mL/d
	2-3 years		1100-1200 mL/d
	4-8 years		1600 mL/d
	9-13 years	Boys	2100 mL/d
		Girls	1900 mL/d
	> 14 years		Cf adults
Adults	Men		2500 mL/d
	Women		2000 mL/d
Pregnant women			+ 300 mL/d *vs* adults
Lactating women			+ 600-700 mL/d *vs* adults
Elderly			Same as adults

EFSA also clarified the contribution of the water from food versus the water from drinks. Despite it being highly variable as it depends on the individual's diet for that day, food contributes on average 20% of the total water intake (EFSA, 2010). This means that on average, 80% of our total water intake should come from the fluid we drink. This gives values ranging from 1.6 L/D of water for women to 2.0 L/D of water for men via drinks. It is important to note that those values have to be adjusted depending on climate and physical activity. Exercising can easily increase water losses through sweat - up to one litre per hour or more. This quantity of water lost by the body has to be compensated through water intake on top of EFSA's Dietary reference values.

Despite variations between Member States, data shows that on average, in most European countries, a significant part of the population is actually drinking less than the values recommended by EFSA. In the interest of those who are not drinking enough, it would therefore be beneficial to promote EFSA's dietary reference values more actively at national level.

The symposium *Adequate Water Intake – Public Health Rational* organised by the European Federation of Bottled Waters (EFBW) gathers International Scientific Experts in their field who will present the science supporting EFSA's scientific opinions.

Dr. Laurent Le Bellego

Chairman of the Health Group of the EFBW

Establishing International Guidelines for Adequate Water Intake

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Water is the matrix which supports digestion, metabolism, nutrient transport, cardiovascular function, and temperature regulation. However, because human activities are very diverse and because body water regulation is complex and dynamic, no consensus exists regarding the water requirements of adults, children, or special populations. This presentation will review the water Adequate Intake (AI) recommendations of nutritional and scientific organizations in Europe, China, Australia and the United States. These recommendations (a) include the total daily fluid intake of drinking water, beverages of all kinds, and food moisture; (b) distinguish youth, older age groups, and special populations such as pregnant women; and (c) apply to conditions of moderate environmental temperature and moderate physical activity levels. This presentation will review the factors that were considered, when each organization developed recommended AI values (i.e., cultural dietary customs, learned drinking habits, dental health, human performance, aging, and relationship of low daily water intake to chronic health outcomes). Further, the following factors will be presented as important considerations for interpreting AI values: water volume per unit of energy consumed, maximal safe water intake, and desirable urine osmolality.

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European health claims: water intake is essential for the maintenance of normal physical function and thermoregulation - a scientific review.

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Water is the most essential constituent of the human body undergoing continuous recycling. Body water functions as a solvent, a means for heat balance, and a regulator of cell volume and overall functioning. Its balance in humans has been regulated to a large extend by the sensation of thirst; a key survival instinct in body fluid homeostasis [1, 2].

For over a century, athletes have noticed that exercise-induced dehydration has been linked to decreased exercise performance. Francisco Lázaro, a Portuguese marathon runner was one of the first to notice that excessive sweating was making him slower. Therefore, he decided to stop dehydration by blocking sweating via application of wax over his skin during the 1912 Stockholm Olympics marathon. Unfortunately, he collapsed at the 30 km mark; and he died next morning from complications of hyperthermia. Since mid 40s, scientists have also been interested in the effect of dehydration on exercise performance. For instance, in 1944, Pitts and his colleagues showed that dehydration, as a response to exercise in the heat, increased thermoregulatory strain and induced exhaustion[3].

Several years later, Armstrong et al examined the effect of hypohydration on exercise performance [4]. They studied the performance of 8 trained, male runners on 1,500 m, 5,000 m, and 10,000 m while normally hydrated or hypohydrated on six separate occasions. Their running performance was reduced by 3.1, 6.7, and 6.3% in the 1,500 m, 5,000 m, and 10,000 m, respectively as a response to hypohydration. This decreased in exercise performance has been shown to be related to a significant decrease of stroke volume and cardiac output during exercise in the heat as a response to hypohydration. In the early 90s, Montain and Coyle concluded that athletes' increase in heart rate and core temperature, as well as, decline in stroke volume was proportional to the degree of hypohydration during exercise[5]. Similarly, Walsh and his colleagues, from the University of Cape Town in South Africa, found that even a mild decrease on hypohydration (-1.8% of body mass) decreased exercise performance; probably due to increased perception of fatigue, as indicated by the greater ratings of perceived exertion [6]. Even thought that during exercise in the heat, hyperthermia and dehydration coincide it has been shown that both, hyperthermia and hypohydration, independently decreased athletes' ability to maintain cardiac output during exercise. Also hyperthermia and dehydration have an additive effect on the decline of cardiac output similar to the sum of the decline for each factor alone [7]. Even though hypohydration has been mainly studied during exercise in the heat, it seems that even in a temperate environment hypohydration can limit exercise performance[8].

In some sports events (ie, uphill cycling), athletes often believe that a decrease in body mass, even via dehydration, can enhance exercise performance by increasing the power to mass ratio. In this respect, Ebert et al. examined the effect of hypohydration during a hill cycling (8% grade) time exhaustion test in a warm environment at intensity equal to 88% of maximal aerobic power (MAP)[9]. Prior to the performance, test subjects cycled for 2 hour at 53% of their MAP, while drinking different volume of fluid in order to achieve the desired pre-exercise body mass (-2.5 vs. +0.3% of body mass). The results showed that even though cyclists were able to reduce their power requirements for any given cycling speed by lowering body mass; hypohydration had a significant detrimental effect on their performance. Hypohydration has been also linked to declined skill performance in sports like basketball, indicating the time to completion basketball-specific movement drill was slower and fewer shot were made when hypohydration reached -2% of body mass [10]. Recently, progressive dehydration induced great thermoregulatory and cardiovascular strain, as well as, whole body carbohydrate oxidation and muscle glycogenolysis [11]. Interestingly, Bardis et al cycling speed and power output were lower in cyclist undergoing dehydration of -1% of their body weight, due to higher body temperature and lower sweating sensitivity [12].

Compelling evidence supports the idea that hypohydration can decrease endurance exercise performance at least in hot and temperate environments, probably due to an increased thermoregulatory strain and cardiovascular decline. More recent data indicate that even a small degree of hypohydration, less than -2% of body mass, might decrease performance; thus, putting into question the current guidelines of the American College of Sports Medicine specifying that the goal of drinking during exercise should be to avoid dehydration greater than -2% of body mass.

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Water Intake is Essential for the Maintenance of Normal Cognitive function - a scientific review

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Failure to maintain adequate hydration leads to a variety of adverse consequences, both physiological and psychological. The physiological effects of dehydration are well documented and are discussed by the other speakers at this symposium. The effects of mild or moderate levels of dehydration on human cognitive function are not as well recognized (Grandjean and Grandjean, 2007; Lieberman, 2007a). When humans or other animals are severely dehydrated the behavioral effects of this state are readily apparent - confusion, lethargy, and degraded cognitive function are present. In fact, in elderly individuals who are confused and disoriented, one of the first medical actions is assessing their state of hydration. Acute or chronic dehydration in elderly individuals can masquerade as much more serious and chronic medical conditions such as Alzheimer's disease (Wotton et al, 2008).

The assessment of cognitive state is a complex undertaking since there are so many different kinds of behavioral functions and a wide variety of methods exist to study them (Gawron, 2000; Lieberman, 2007b). Cognitive function includes a vast array of mental capabilities and states. Functions such as vigilance, learning, memory, reasoning, speech perception and hundreds of other activities are aspects of cognitive performance. Cognitive functions also include moods, symptoms and emotions such as alertness, sadness, anxiety, and anger. Any of these may be sensitive to the effects of mild or moderate dehydration. However, only a small number of studies have been conducted to examine the effects of dehydration on cognitive function and only a few cognitive measures utilized in these studies. As with research on many stressors, most studies of dehydration have measured cognitive performance and mood. These studies clearly demonstrate that relatively high levels of dehydration, over 3% loss of body weight, impair both performance and mood. However, the effects of more moderate levels of dehydration are more controversial and the level of dehydration where cognitive function is first impaired has not been definitely established (Lieberman, 2007a). Several studies conducted in the 1980's at an Indian Defense Institute found that dehydration induced by exposure to high heat and exercise impaired specific aspects of cognitive function in healthy young men including short-term memory, reasoning and coordination. These deficits were apparent at 3% or higher levels of dehydration (Gopinathan et al, 1988; Sharma et al, 1986). Another more recent study, conducted with young male and female volunteers, induced a mean level of dehydration of 2.6% by 28 hours of fluid deprivation (Szinnai et al, 2005). This study found that mood states such as tiredness and concentration were degraded at this level of dehydration but that cognitive performance was not affected, although females appeared more sensitive than males.

Recently, my colleagues at the University of Connecticut and I conducted two studies, using nearly identical methods, designed to assess the effects of mild dehydration on cognitive function (Armstrong et al, 2012; Ganio et al, 2011). One study was conducted with 26 young men and other with 25 young women. Dehydration was induced by moderate exercise in comfortable conditions. Both of these studies used a crossover procedure such that each individual was tested in a dehydrated and euhydrated state so each could serve as his/her own control. We assessed cognitive function using a comprehensive computerized battery of tests of cognitive performance, mood and symptoms associated with dehydration. The men in the study reached a 1.59% level of dehydration the women were 1.36% dehydrated on average. We found, in both men and women, that these levels of dehydration induced fatigue and degraded a specific aspect of cognitive function, vigilance. Women reported headache, confusion and lack of energy when mildly dehydrated and appeared somewhat more sensitive to the adverse effects of dehydration than men. These studies demonstrate that mild dehydration, which can occur over the course of daily activities, degrades cognitive function. They indicate how important it is to main adequate hydration by regularly consuming water so that optimal cognitive performance and mood are maintained throughout the day and adverse symptoms such as headache and fatigue are avoided.

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About EFBW

EFBW is the voice of the European bottled water industry. A not-for-profit trade association with a membership base that includes national associations, companies and scientific bodies, EFBW collectively represents more than 600 producers of natural mineral water* and spring water* across Europe.

The Federation works to ensure that naturally sourced waters continue to offer a high quality, pure and convenient way to hydrate, and represents a sustainable and responsible choice for Europeans. The sector accounts for more than 158,000 direct employees throughout the production chain.

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* Natural mineral waters and spring waters must both be from a designated underground origin only and be safe to drink at source, where they must be bottled directly. They may not be disinfected nor chemically treated.

In addition, natural mineral waters are characterised by their original purity and their stable mineral content as indicated on the label. In some cases, natural mineral waters can also be characterised by some health effects.

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