Fluid and water balance

Introduction

Safe water, for drinking and sanitation, is critical to maintain good health. This pivotal role of water is derived from several human rights provisions, i.e. the Convention of the Rights of the Child (Article 24) and the International Convention on Economic, Social and Cultural Rights (elaborated in General Comment 15), and highlighted in Voluntary Guideline 8c on the Right to Adequate Food adopted by FAO.

According to WHO 2,5 million children suffer annually from diarrhoea and malnutrition due to unsafe water, and improvement in water standard in large parts of the world could have a profound impact on the incidence of many infectious diseases that affects millions of people of all ages.

Dietary intake

The usual volume of ingested water and other fluids amounts to 1000-2000 ml per day in the Nordic countries. This brings the total amount of available water to 2000-3500 ml per day, which is about 10 % of total body water.

Physiology and metabolism

Water is the main component of the human body and vital for many organ functions and thermoregulation. The water content as a fraction of body weight is usually smaller in women than in men and varies with age, from about 75% in newborns to about 50% in the elderly. Approximately 2/3 of the total body water is confined to the intracellular compartment whereas the remaining 1/3 is located extracellularly, with about 75% in the interstitium and 25% as plasma (1).

The regulation of fluid balance is closely linked to the regulation of electrolyte balance. In the kidneys, the excretion of water and electrolytes is regulated by hormones, in particular the antidiuretic hormone and aldosterone. With excess water in the body, diluted urine is excreted. If there is too high a concentration of electrolytes in body fluids, the thirst centre in the brain is stimulated, which leads to a feeling of thirst and reduced excretion of water by the kidneys.

Foods provide on average 1,000 to 1,500 ml water per day, but the water content in food items may vary considerably, from about 20% in cheese to 90% in fruit and vegetables. Intake of drinking water and beverages provide varying amonts. Oxidation of fat, carbohydrates and protein yields 300 to 350 ml water per day. Loss occurs by four routes: urinary output and the water in stools, and by evaporation from the respiratory tract and the skin. The daily urinary output exceeds 600 ml in healthy adults and is normally between 1,000 and 2,500 ml. The water content of stools is generally 100 to 200 ml per day, but may be increased considerably by diarrhoea. The daily insensible losses by evaporation are on average 300 to 500 ml per m^2 body surface in a temperate climate. Losses by

sweating are generally small, but they may increase to several litres per day in a warm and humid environment or with heavy exercise in temperate conditions.

During total parenteral nutrition, the daily requirement for total water is generally considered to be 30 ml per kg body weight, corresponding to 2,250 ml for a 75 kg healthy person living in temperate conditions and performing moderate physical activity.

Requirement and recommended intake

The vast majority of healthy people adequately meet their daily hydration needs by letting thirst be their guide. It is virtually impossible to give exact recommendations on daily water intake for healthy subjects since the requirement for fluids shows considerable inter-individual variations, and is confounded by physical activity patterns and the ambient climate. Moreover, the evidence is insufficient to establish water intake recommendations as a means to reduce the risk of chronic diseases like e.g cancer, cardiovascular- and metabolic disorders (2,3).

The Institute of Medicine has set general recommendations for adequate intake (AI) for women at approximately 2.7 liters of total water from all beverages and foods daily, and for men an AI of approximately 3.7 liters, but did not set an upper level for total water intake (3).
Moreover, in the US the AI for total water was set to 1.3 litres per day for children 1-3 years and 1.7 litres per day for children 4-8 years of age, 2.4 and 2.1 litres per day for 9-13 year old boys and girls respectively, and 3.3 and 2.3 litres per day for 14-18 year old boys and girls, respectively (4).

The European Food Safety Authority (EFSA) recommends that the AI of total water should be 2.0 and 2.5 litres daily for adult women and men, respectively (5). The AI for total water per day was set to 0.8-1.0, 1.1-1.2, 1.3 and 1.6 litres for children aged ½ to 1, 1-2, 2-3 and 4-8 years, respectively. Furthermore, the daily AI for the age group 9-13 years should be 2.1 litres for boys and 1.9 litres for girls. The recommended AI for children aged 14 years and above was similar to that of adults.

EFSA gives similar recommendations for AI of total water for non-pregnant and pregnant women, plus 0.3 litres extra per day during pregnancy (5). Lactating women increase their fluid intake in relation to the volume of breast milk. A volume of 750 ml per day of breast milk during the first six months increases the requirement for fluid by about 600-700 ml per day. This is generally compensated for by a self-regulatory increase in fluid intake of 12-16 % (6). EFSA recommends that lactating women have the same daily AI of total water as non-lactating women plus an extra 0.7 litre (5).

For elderly people, whose capacity to concentrate the urine is limited and who often have impaired feeling of thirst, a broader safety margin may be needed, but EFSA does not recommend a specific AI for total water intake among the elderly (5).

The guiding value for daily intake of drinking fluids for adults performing moderate physical activity and living under moderate temperate conditions is thus 1 – 1.5 litres in addition to that derived from foods.

Lower and upper limits of intake

Mild dehydration defined as a 1% to 2% loss of body weight caused by fluid losses may result in headache, fatigue, loss of appetite and vertigo, while dehydration in excess of 3% to 5% of body

weight decreases endurance and strength and is the primary cause of heat exhaustion (7). Dehydration of 15% to 25% body weight lost as water is fatal (8).

Acute water toxicity has been reported (9) due to rapid consumption of large quantities of fluids that greatly exceed the kidney's maximal excretion rate of 0.7-1.0L/hour (5). Excessive ingestion of water may increase the risk of water intoxication and hyponatraemia during pregnancy (6). However, it is not possible to define a maximum daily amount of water that can be tolerated by a population group, without taking into account individual and environmental factors (5).

Hydration status in relation to coffee and alcohol

Coffee is reported to increase 24-hour urine excretion in subjects with no habitual intake (10), while hydration status seemed unaffected in habitual coffee drinkers (11). As the main diuretic compound in coffee and tea is caffeine, it seems as if caffeine tolerance develops after habitual consumption, and reportedly there is no basis for restricting caffeine consumption in order to avoid either dehydration or overhydration (12).

Alcohol (ethanol) has a diuretic effect by inhibiting the secretion of antidiuretic hormone, but moderate amounts of alcohol such as beer and wine seem to have little or no effect on hydration status (13).

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