

LIFE IN THE BALANCE?

- ✓ Maintaining water balance is essential to normal physiologic functioning and healthy living.
- ✓ Evidence suggests that dehydration is widespread in the population, although most data relate to specific groups such as athletes, children and the elderly.
- ✓ Data support the role of dehydration in headache, UTI and kidney stones as well as in feelings of fatigue, loss of concentration and cognitive deterioration.
- ✓ Increasing fluid intake needs care to avoid additional calories via sweetened drinks.

REFERENCES

1. Noakes TD. Fluid replacement during exercise. *Exerc Sport Sci Rev* 1993;21:297-330.
2. Manz F. Hydration and disease. *J Am Coll Nutr* 2007;26(Suppl 5):S535-41.
3. Szinnai G, et al. Effect of water deprivation on cognitive-motor performance in healthy men and women. *Am J Physiol Regul Integr Comp Physiol* 2005;289:R275-80.
4. Blau JN, et al. Water-deprivation headache: a new headache with two variants. *Headache* 2004;44(1):79-83.
5. Kleiner SM. Water: an essential but overlooked nutrient. *J Am Diet Association* 1999;2:200-6.
6. Dietary reference intakes for water, potassium, sodium, chloride, and sulfate. Panel on dietary reference intakes for electrolytes and water, standing committee on the Scientific Evaluation of Dietary Reference Intakes. National Academies Press, 2005.
7. Grandjean A, et al. Hydration: issues for the 21st century. *Nutrition reviews* 2003;61(8):261-71.
8. Kenefick RW and Sawka MN. Hydration at the work site. *J Am Coll Nutr* 2007;26(Suppl 5):S597-603.
9. Passe D, et al. Voluntary dehydration in runners despite favorable conditions for fluid intake. *Int J Sport Nutr Exerc Metab* 2007;17(3):284-95.
10. Bergeron MF, et al. Voluntary fluid intake and core temperature responses in adolescent tennis players: sports beverage versus water. *Br J Sports Med* 2006;40:406-10.
11. Kaushik A, et al. A study of the association between children's access to drinking water in primary schools and their fluid intake: can water be 'cool' in school? *Child Care Health Dev* 2007;33(4):409-15.
12. Volkert D, et al. Nutrition beyond 65 – amount of usual drinking fluid and motivation to drink are interrelated in community-living, independent elderly people. *Z Gerontol Geriatr* 2004;37(6):436-43.
13. Bennett J, et al. Unrecognized chronic dehydration in older adults: examining prevalence rate and risk factors. *J Gerontol Nurs* 2004;30(11):22-8.
14. Ritz P and Berrut G. The importance of good hydration for day-to-day health. *Nutr Rev* 2005;63(6 Pt 2):S6-13.
15. McKinley M and Johnson A. The physiological regulation of thirst and fluid intake. *News Physiol Sci* 2004;19:1-6.
16. Cohn E and Larson E. Improving participant comprehension in the informed consent process. *J Nurs Scholarsh* 2007;39(3):273-80.
17. Butterworth S. Influencing patient adherence to treatment guidelines. *JMCP* 2008;14(6):S-b.
18. Armstrong LE, et al. Hydration assessment techniques. *Nutr Rev* 2005;63(6 Pt 2):S40-54.
19. Schliess F and Haussinger D. The cellular hydration state: a critical determinant for cell death and survival. *Biol Chem* 2002;383(3-4):577-83.
20. Ritz P, et al. Effects of changes in water compartments on physiology and metabolism. *Eur J Clin Nutr* 2003;57(Suppl 2):S2-5.
21. Haussinger D, et al. Regulation of cell function by the cellular hydration state. *Am J Physiol* 1994;267(3 Pt 1):E343-55.
22. Gopinathan PM, et al. Role of dehydration in heat stress-induced variations in mental performance. *Arch Environ Health* 1988;43(1):15-7.
23. Wilson MM and Morley JE. Impaired cognitive function and mental performance in mild dehydration. *Eur J Clin Nutr* 2003;57(Suppl 2):S24-29.
24. Cian C, et al. Influence of variations in body hydration on cognitive function: effect of hyperhydration, heat stress, and exercise-induced dehydration. *J Psychophysiol* 2000;14:29-36.
25. Maughan RJ. Impact of mild dehydration on wellness and on exercise performance. *Eur J Clin Nutr* 2003;57(Suppl 2):S19-23.
26. Lieberman HR. Hydration and cognition: a critical review and recommendations for future research. *J Am Coll Nutr* 2007;26(Suppl 5):S555-61.
27. Blau JN. Water deprivation: a new migraine precipitant. *Headache* 2005;45(6):757-9.
28. Armstrong LE, et al. Influence of diuretic-induced dehydration on competitive running performance. *Med Sci Sports Exerc* 1985;17(4):456-61.
29. Below PT, et al. Fluid and carbohydrate ingestion independently improve performance during 1 h of intense exercise. *Med Sci Sports Exerc* 1985;27(2):200-10.
30. Nygaard I and Linder M. Thirst at work – an occupational hazard? *Int Urogynecol J* 1997;8:340-3.
31. Grandjean AC and Grandjean NR. Dehydration and cognitive performance. *J Am Coll Nutr* 2007;26(Suppl 5):S549-54.
32. Shirreffs SM, et al. The effects of fluid restriction on hydration status and subjective feelings in man. *Br J Nutr* 2004;91(6):951-8.
33. Coyle EF. Fluid and fuel intake during exercise. *J Sports Sci* 2004;22:39-55.
34. Sanchez-Gonzalez JM, et al. Hydration status and aerobic capacity: effects on plasmatic volume during strenuous physical exercise. *Cir Cir* 2005;73(4):287-95.
35. Schroeder C, et al. Water drinking acutely improves orthostatic tolerance in healthy subjects. *Circulation* 2002;106:2806-11.
36. Beetz R. Mild dehydration: a risk factor of urinary tract infection? *Eur J Clin Nutr* 2003;57(Suppl 2):S52-8.

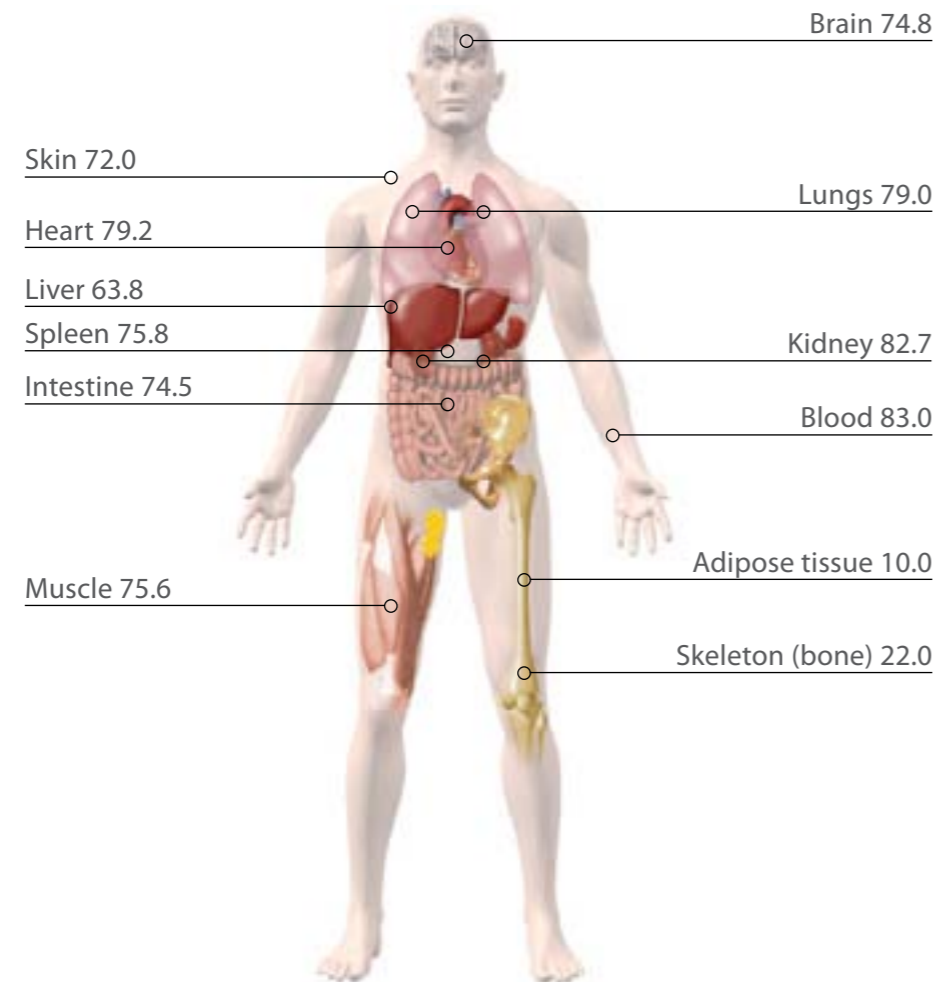


HYDRATION FOR HEALTH – ARE THEY RUNNING ON EMPTY?

- ADULTS UNDERESTIMATE AND UNDERCOMPENSATE FOR WATER LOSSES¹
- DEHYDRATION HAS WHOLE-SYSTEM EFFECTS² INCLUDING TIREDNESS,³ AND

WATER – AN ESSENTIAL BUT OVERLOOKED NUTRIENT⁵

Water composition of tissues and organs (% by weight)



Water is the largest constituent of the human body and is essential for cellular homeostasis and life.⁶

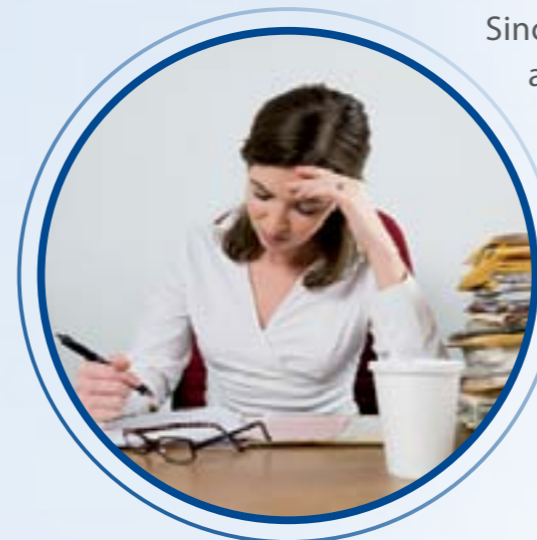
DEHYDRATION AT WORK

Hydration research relevant to 'average' adults is scanty. This is a consequence of six decades of research being focused primarily on the military, athletes and hospitalised patients.⁷ Some occupational data, however, have been produced including research that shows a direct link between dehydration and the risk of accidents at work. In hot temperatures people lose water more easily and can become dehydrated, having an impact on the incidence of headaches and fatigue.⁸

Maintaining water balance is essential to normal functioning. Effects from dehydration include metabolic and functional abnormalities.⁶ Yet data from specific population groups reveal widespread sub-optimal fluid intake. For example, in a sports setting, studies of the nutritional and hydration habits of amateur and professional players show that rehydration fails to match output.^{1,9} This is also observed in teenagers.¹⁰ Data from schools find high levels of voluntary dehydration,¹¹ and elderly populations in the community as well as in hospital have hydration issues.^{12,13}

Since even mild water depletion can cause side effects such as loss in alertness, concentration, short-term memory,¹⁴ headache⁴ and tiredness,³ improving patient awareness about the health benefits of drinking appropriate quantities of fluid is essential.

This brochure highlights some of the key issues concerning hydration status in ordinary working and active people.

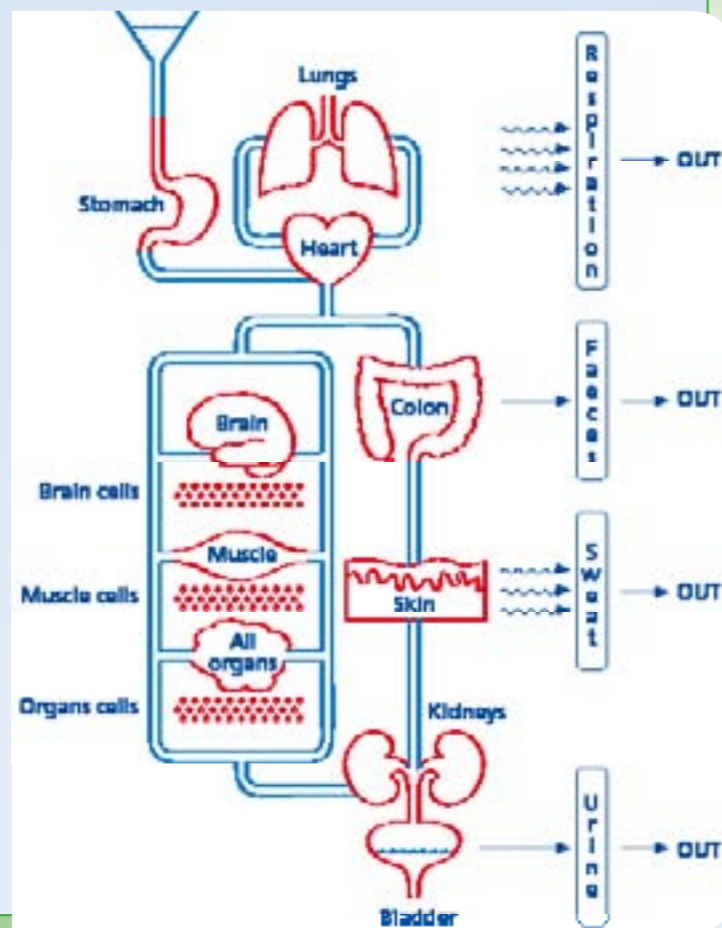


PATIENT COMMUNICATION AND THE ROLE OF WATER

Homeostatic regulation of fluid intake by the brain is multifactorial involving also habitual, cultural and psychogenic drives.¹⁵ The compensatory responses when there is a depletion of water supplies do not restore body fluids to the original state; replenishment is therefore essential to maintain fluid balance.¹⁵

Patients consistently misunderstand healthcare advice¹⁶ and/or fail to adhere.¹⁷ Explaining quickly and visually how water is an essential component and facilitator of all cells may help patients adjust understanding.

A useful analogy to convey the role water plays in the body may be the 'water-powered engine'. To enable patients to appreciate the role hydration plays in health it may be appropriate to dispel any misunderstandings that, for example, water just goes in at one end and straight out the other.



Adults are about 60% water¹⁸ and the body depends on maintenance of water balance to work properly.

Water is essential to:

- Passage of nutrients and oxygen into cells
- Chemical reactions that power cells
- Transport of waste out of cells.

CELLULAR HYDRATION STATE MAY BE A CRITICAL DETERMINANT OF CELL DEATH OR SURVIVAL¹⁹

Body water balance depends on the net difference between fluid gain and fluid loss. When the body loses water, it is lost from both extracellular and intracellular spaces although the losses may not occur equally.¹⁵

Data on the effects of changes in water compartments on physiology and metabolism are from mostly in vitro studies.²⁰ Changes in cell hydration appear to contribute to metabolic regulation while also determining response to different stresses. Cell dehydration may, for example, have a role in insulin resistance and catabolism while increasing susceptibility to stress-induced damage.¹⁹

Changes in cell hydration have been seen to occur within minutes in response to hormonal influences, nutrients and oxidative stress. Alterations in cellular hydration may represent an important mechanism for metabolic control and gene expression.²¹

If theories about the role of cell swelling are confirmed, strategies that modify cellular hydration could be used in some metabolic disorders.²⁰



GOOD HYDRATION MAINTAINS MENTAL PERFORMANCE

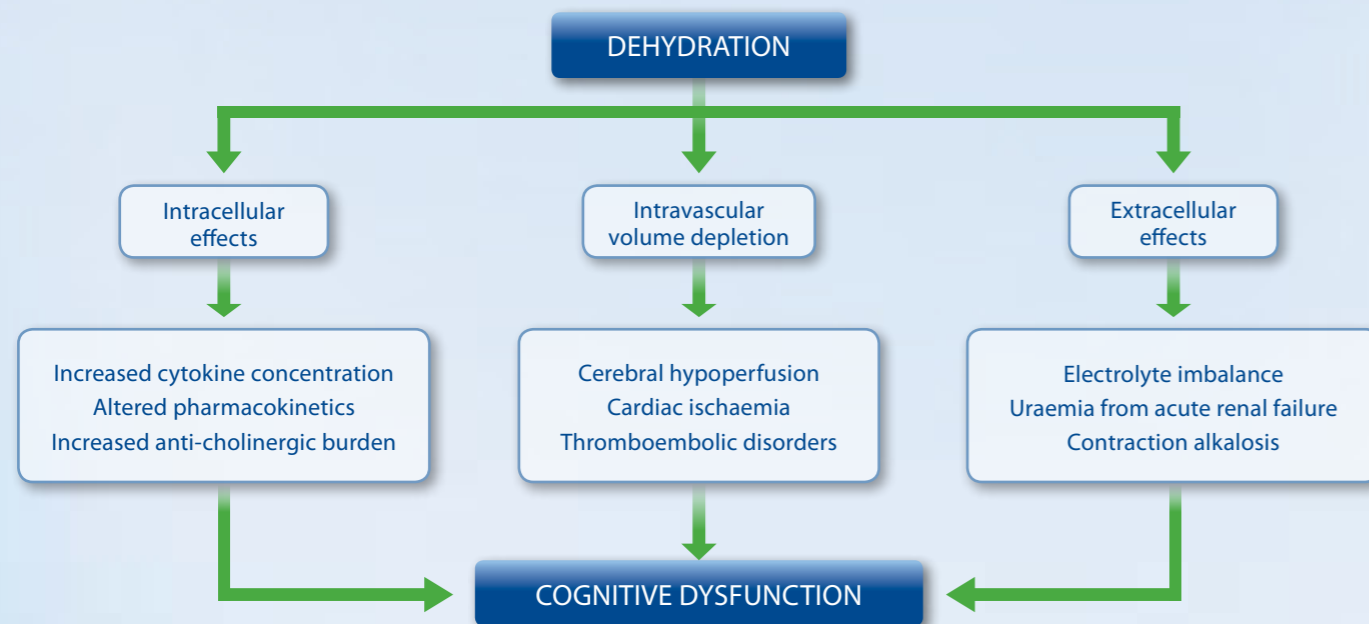
Numerous reports present findings that dehydration can adversely impact on cognitive function; these were reviewed recently by the National Academies' Institute of Medicine.⁶ Some researchers report significant deterioration in mental function at 2% or more body dehydration levels.²²

An association between hydration status and quality of life is proposed²³ drawing on data demonstrating increased perception of fatigue and tiredness.

Perception of fatigue in one study of 8 men found increased ratings of fatigue at 2.8% dehydration resulting from exercise or heat.²⁴

Short periods of fluid restriction prompt reported feelings of tiredness, difficulties concentrating and perceptions of reduction in alertness.²⁵ Short-term memory loss and attention difficulties are seen at 2%.²⁶

Pathophysiology of cognitive dysfunction in moderate and severe dehydration²³



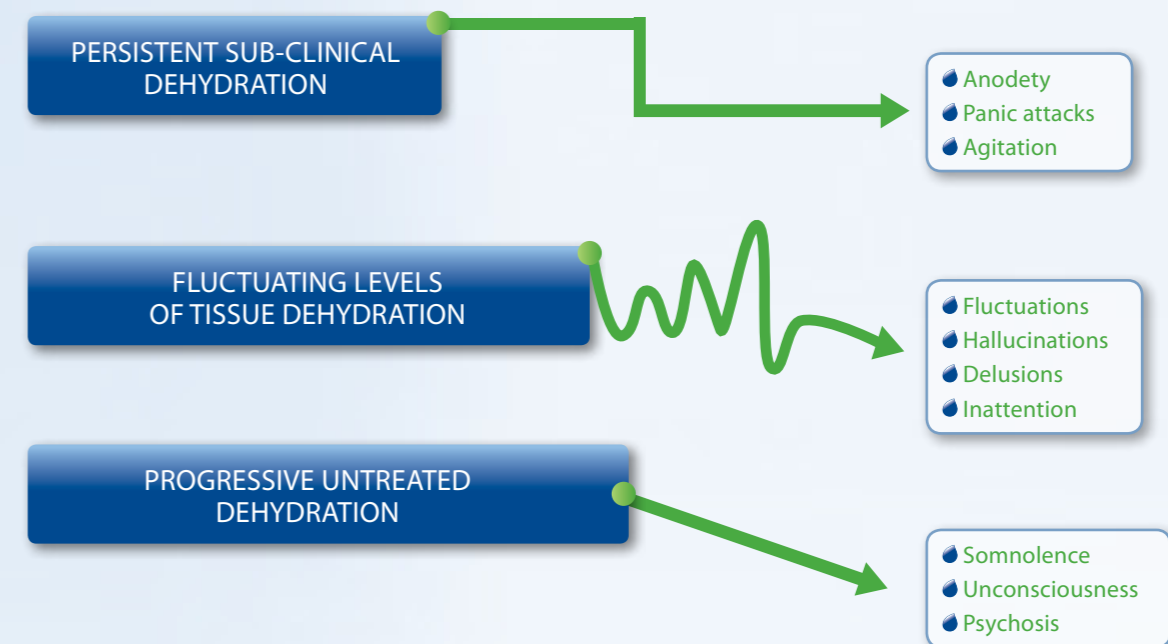
Pathway proposed by Wilson and Morley (2003)²³

DEHYDRATION AND THE BRAIN

Water depletion is involved in a range of cognitive and neurological effects:

- Loss of concentration¹⁴
- Tiredness³
- Short-term memory¹⁴
- Headache⁴
- Migraine²⁷

Theoretical model of the clinical trajectories of cognitive dysfunction resulting from variable degrees of dehydration.²³



Pathway proposed by Wilson and Morley (2003)²³

The three areas of the brain most vulnerable to the effects of dehydration are:

- Reticular activating system (attention and wakefulness)
- Autonomic structures regulating psychomotor and regulatory functions
- Cortical and mid-brain structures responsible for thought, memory and perception.

Even mild dehydration adversely affects alertness, concentration and short-term memory.¹⁴

WATER-EMPOWERED EXERCISE

Dehydration can adversely influence aerobic and endurance-type exercise performance as well as anaerobic exercise.⁶

Runners slow up when dehydrated

Trained runners racing at 1500m, 5km and 10km were seen to slow down by 3.1%, 6.7% and 6.3%, respectively if they were dehydrated.²⁸



Hydrated cyclists go faster²⁹

Are your patients only 2/3rds full? Studies show even professional athletes don't hydrate adequately to replace water losses.¹



WORKPLACE DEHYDRATION IS AN OCCUPATIONAL HEALTH ISSUE

Dehydration is an issue in the workplace too and can adversely affect physical work capacity.⁸ Access to fluids in the workplace can also be a factor for some sectors.³⁰

Several studies have demonstrated a link between dehydration and impaired mental, visuomotor and cognitive performance,^{31,32} leading in some situations to an increased risk for accidents.⁸

Studies of occupational accidents report the lowest rates in cold months and highest rates in hot months when sweat losses would be greatest. This supports the hypothesis that dehydration could lead to an increase in the risk of accidents:

Relationship between the number of industrial accidents by month and the temperature⁸



Dehydration may lead to increased accidents.

DEHYDRATION AND THE HEART

Exercise increases cardiovascular strain and in situations of dehydration, for every 1% of body weight lost, heart rate increases by 5 beats per minute.³³

Water loss during exercise leads to a decrease in plasma volume and blood flow. The heart's capacity to work is then affected and physical performance decreases along with a deterioration in aerobic capacity.³⁴

SYNCOPE

In healthy people who have fainted, drinking 500ml of water has been shown to increase orthostatic tolerance within 15 minutes.³⁵

Drinking water may delay the onset of neurally mediated pre-syncope

Patients should be advised to drink water before a situation that might trigger syncope such as standing for long periods or exposure to high temperatures.³⁵



CHRONIC DEHYDRATION MAY PRECIPITATE URINARY TRACT INFECTIONS (UTI)

Poor fluid intake or low urine output are both factors that predispose individuals to UTI.²

Fluid intake exerts an influence on the composition of urine, on urine volume, on micturition frequency, on renal perfusion, and on the osmolality of the renal medulla.³⁶

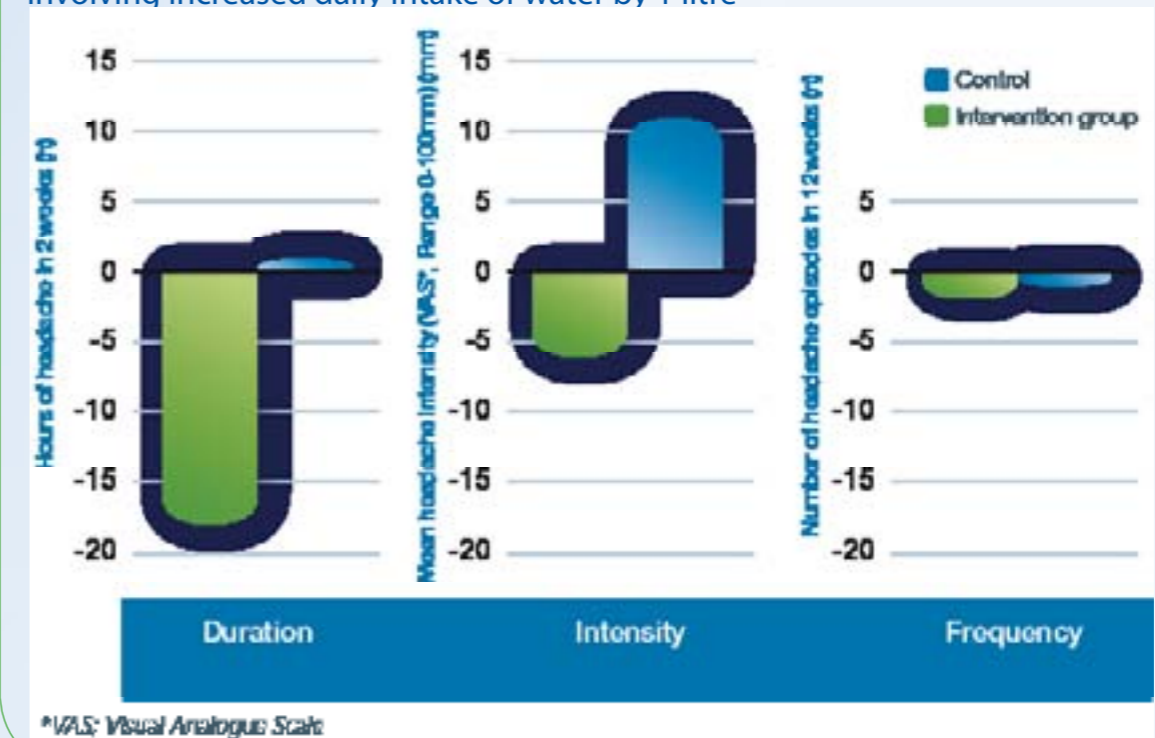
Mild dehydration may play a role in the growth of bacteria in both the upper and lower urinary tract. This is thought to be related to increased concentrations of mucus, bacterial nutrients and urea in the urine of mildly dehydrated people.³⁶

HEADACHE

Water deprivation headache has recently been described as a primary headache postulated as arising from the meninges. Dehydration may play a role in triggering migraine as well as playing a part in prolonging existing attacks.^{4,27}

Some researchers have shown that increasing water intake can reduce the length and lessen the intensity of headaches. An intervention study in which frequent headache sufferers increased their daily water intake by 1 litre resulted in reduced duration, and intensity of headaches.³⁷

Reduced duration and intensity of headaches after intervention involving increased daily intake of water by 1 litre³⁷



THERAPEUTIC ROLE FOR WATER

Conclusions about the role of water in treating and preventing certain diseases is made difficult by the absence of any gold standard for the assessment of hydration status.³⁸ There is also considered to be a general lack of evidence to support or deny the benefits of increasing fluid consumption in healthy individuals,³⁹ while data exist to support the benefits of maintaining fluid balance.

There are, however, numerous studies, some of which are cited here, that support the hypothesis that increased total water intake may be effective to prevent recurrent kidney stones, UTIs and headache, while maintaining or restoring water balance may play a part in optimising cognitive function and general feelings of well being.