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Drink plenty of water daily

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1. Terminology

Alcoholic beverage

An alcoholic beverage is a drink containing more than 2 percent volume per volume (2% by volume) of ethanol or commonly known as alcohol (MOH, 2008).

Beverage

A beverage refers to any one of various liquids suitable for drinking, excluding plain water. This may include tea, coffee, liquids, beer, milk or soft drinks.

Dehydration

Dehydration is excessive loss of body water. There are a number of causes of dehydration including heat exposure, prolonged vigorous exercise, vomiting, diarrhoea, kidney disease and medications (diuretics).

Hydration

Hydration is a process of providing an adequate amount of liquid to body tissues.

Total body water

Total body water (TBW) comprises extracellular fluid (ECF) and intracellular fluid (ICF); averages approximately 60% of body weight, with a range of approximately 45 to 75%. Variability in TBW is primarily due to differences in body composition.

Water

Water is a substance with chemical formula H_2O : one molecule of water has two hydrogen atoms covalently bonded to a single oxygen atom. Water is a tasteless, odourless liquid at room temperature and pressure and appears colourless.

2. Introduction

Water is the principal chemical constituent of the human body. It absorbs metabolic heat within the body, maintains vascular volume and serves as the medium for transport within the body by supplying nutrients and removing waste. Daily water intake must be balanced with losses in order to maintain total body water. Body water deficits challenge the ability of the body to maintain homeostasis during perturbations and can affect function and health. On the other hand, excess consumption of plain water and low sodium intake may lead to excess body water, resulting in low sodium concentration in the blood and cellular oedema. Despite the importance of adequate water intake, there is confusion among the general public and health care providers on the amount of water that should be consumed.

3. Scientific basis

Factors affecting water requirements

There are several factors affecting water requirements:

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3.1 Environmental factors

Physical activity and heat strain

Numerous dietary studies have demonstrated that on average, athletes do not consume adequate fluids before, during, or after exercise (Burke, 1997; Noakes, 2002). Many athletes habitually self-induce dehydration to qualify for a designated weight category for competition (Fogelholm *et al.*, 1993; Tarnopolsky *et al.*, 1996). This practice can dramatically influence exercise performance, including losses in strength, anaerobic power, anaerobic capacity, lactate threshold and aerobic power (Fogelholm, 1994). In extreme cases, self-induced dehydration practices have resulted in death.

In contrast, there are athletes that over consume fluids either as plain water or sports drinks before, during, or after exercise. This is unnecessary and can have a potential fatal outcome. Noakes (2002) suggested that fluid intake requirement should range between 400 ml to 800 ml per hour in most forms of recreational and competitive exercise. Slower runners will require the lower amount, while faster runners will need the larger amount, especially under hot, humid conditions. Recommendations for adequate fluid intake before, during, and after exercise have been made by the American College of Sports Medicine (Convertino *et al.*, 1996). Careful attention to these guidelines will help avoid dehydration, as well as the hyperhydration that has periodically been associated with endurance exercise (Noakes, 1992).

Environmental conditions influence fluid losses. When exercise is performed in excessive heat or cold, low humidity, or high altitude, fluid losses increase (Bergeron, Armstrong & Maresh, 1995; Brouns, 1992).

Sweat rates of 1 to 2 liters per hour are

typical of most persons performing moderately hard exercise, but sweat rates in excess of 2 liters per hour (as high as 4 to 6 liters per hour) are not unusual when the ambient temperature is high (Maughan, Leiper & Shirreffs, 1996). A study comparing the effects of exercise on thermoregulation between Japanese and Malaysian males found that the Malaysian males had higher thresholds of temperature for sweating. This showed that Malaysians had stronger heat tolerance compared to the Japanese who had increased sweat rates. The total number of active sweat glands is thought to be dependent on the climate where the individual lives (Mohamed *et al.*, 2005).

Altitude and cold

Water requirement at high altitude is increased due to the decrease in atmospheric pressure as well as the partial pressure of oxygen (Richalet & Herry, 1990; Westerterp, 2001). People who are unacclimatised to high altitude may develop a syndrome called acute mountain sickness (AMS). The symptoms include headache, nausea, dizziness, anorexia, lassitude, weakness and sleeplessness (Richalet & Herry, 1990). Increased water losses at high altitude include increased respiratory water vapour volume which is approximately 200 ml per day above the usual baseline of 250 ml per day, hypoxia-induced diuresis, reduced fluid consumption (approximately 2 to 3 litres over several days) and possibly increased sweating from the high metabolic rates needed to traverse rugged mountain terrains. The net effect is a total body water deficit reduction during altitude exposure (Anand & Chandrashekar, 1996; Hoyt & Honig, 1996).

The critical altitude cannot be defined exactly but starts between 5,000 and 6,000 meters (Westerterp, 2001). Nerin *et al.*, (2006)

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reported that fluid intake was not associated with incidence and degree of AMS. It is suggested that immediate fluid intake is protective to prevent AMS.

3.2 Dietary factors

Caffeine

Caffeine is naturally present in coffee, tea and chocolate, added to colas and other beverages (IOM, 2001). It has long been thought that consumption of caffeinated beverages, because of the diuretic effect of caffeine on reabsorption of water in the kidney, can lead to loss of body water. However, available data are inconsistent. Caffeine-containing beverages did not increase 24-hour urine volume in healthy, free-living men when compared with other types of beverages for instance water, energy-containing beverages, or theobromine-containing beverages (Dorfman & Jarvik, 1970; Grandjean *et al.*, 2000). In aggregate, available data suggest that higher doses of caffeine (above 180 mg per day) have been shown to increase urinary output, perhaps transiently, and that this diuretic effect occurs within a short time period (Passmore, Kondowe & Johnston, 1987). Hence, unless additional evidence becomes available indicating cumulative total water deficits in individuals with habitual intakes of significant amounts of caffeine, caffeinated beverages appear to contribute to the daily total water intake similar to that contributed by non-caffeinated beverages (Food and Nutrition Board, 2004).

Alcohol

Alcohol is not a nutrient but does provide energy to the body. One gram of alcohol contains approximately 7 kcal or 29 kilojoules per gram (Wardlaw & Hampl,

2007). Therefore, alcohol consumption has the potential to affect dietary intakes of nutrients.

A study of dietary practices of adolescents in Singapore and Malaysia showed that in Singapore about 20.5 % of adolescents consumed alcohol once a week or less and 1.2% consumed alcohol 7 times a week or more, whereas, in Malaysia it was reported that 45.9 % of adolescents in one study consumed alcohol once per week or less (Lew & Barlow, 2005). It was reported that the highest percentage of consumers of alcohol among Malaysians was in the age group of 25 to 34 years (14.6%). Intake was highest among Chinese (24.2 %) and Sarawak was the state that had the highest consumption of alcohol (Disease Control Division, 2006).

Alcohol, the active ingredient in alcoholic drinks, has a diuretic effect that will increase fluid loss through urination. Therefore, for individuals who suffer from incontinence or need to pass urine frequently, it is recommended to avoid alcoholic beverages. Because of its diuretic effect, alcoholic beverages are not recommended to satisfy thirst or to be consumed as a rehydration fluid. A study which examined the effects of alcohol on hydration has revealed that consumption of alcoholic beverages after physical exercise delays the normal return of plasma viscosity and this might be linked with the alcohol induced dehydration property (El-Sayed, 2001). Alcoholic beverages, especially those containing 4% alcohol, tend to delay the restoration of fluid balance after exercise-induced dehydration (Susan & Ronald, 1997). Therefore, alcoholic beverages should be completely avoided until one is fully hydrated from the dehydration state.

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Sodium intake

The effects of increased sodium intake on urine volume, a proxy of water intake, have been assessed in two experimental studies (He *et al.*, 2001; Choukroun *et al.*, 1997). In one study, 24 men were given 0.23, 4.6 and 9.2 g (10, 200 and 400 mmol)/day of sodium for 7 days while energy, potassium and protein intakes were maintained at a constant level (Luft *et al.*, 1983). In spite of a 40-fold increase in sodium intake, little change was noted in urine volume (which averaged 2.1 litres on the lowest sodium intake level and 2.3 litres on the highest). In another study, 104 hypertensive subjects (48 men and 56 women) were studied after 5 days on approximately 8 g (350 mmol) per day of sodium and again after 5 days on 0.23 to 0.5 g (10 to 20 mmol) per day of sodium (He *et al.*, 2001). Twenty-four-hour urine excretion volume was 2.2 litres at the higher sodium level, but significantly less amount, just 1.3 litres, on the lower sodium level.

3.3 Basis for recommendation

There are two recommendations that are available for water intake: Recommended Dietary Allowances (RDA) and Recommended Nutrient Intakes (RNI). The earliest recommendation (RDA) for water came in the 1945 prescription by the Food and Nutrition Board (FNB) of the United States National Research Council. It was based on research at the time suggesting an intake of *1 ml of water for each calorie eaten* (Food and Nutrition Board, 1940). The RDA for water is a recommendation calculated to meet the needs of nearly all healthy individuals of each gender and life stage group. The RDAs are determined by using the Estimated Average Requirement (EAR) value and using the variability in the requirements among individuals to increase it to an amount that

meets the needs of 97% to 98% of healthy individuals.

The RDA was expanded and was later known as Dietary Reference Intakes (DRI). The DRI comprises a set of reference values for specific nutrients, each category of which has special uses. The DRI for water is as in Appendix 1.

The development of DRIs expands on the periodic reports of RDA, published from 1941 to 1989 by the National Academy of Sciences. Age and gender specific Adequate Intakes (AI) for water were established in 2004 by FNB (Food and Nutrition Board, 2004). In the judgment of the Standing Committee of the Scientific Evaluation of DRI, the AI is expected to meet or exceed the amount needed to maintain a defined nutritional state or criterion of adequacy in essentially all members of a specific, apparently healthy, population. Examples of defined nutritional states include normal growth, maintenance of normal circulating nutrient values, or other aspects of nutritional well-being or general health.

The Recommended Nutrient Intake (RNI) for Malaysia was published by the Ministry of Health in 2005. Age categories in the RNI covered infants (0 to 5 months and 6 to 11 months), adults (aged 19 to 29 years and 30 to 59 years) and the elderly (60 years and above). The RNI for Malaysia (NCCFN, 2005) did not include recommendations for water, but included recommendations for energy according to age group and gender.

Together with the available data on energy requirement in the Malaysian RNI and the recommendation by the Food and Nutrition Board of the National Research Council (1945) which is *1 ml of water for each calorie eaten*, the recommendation for water could be established (Table 11.1).

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However, the water stated here includes both beverages and plain water. In order to derive the recommendation for plain water only, results from the Malaysian Adult Nutrition Survey (MANS) 2003 were used.

According to the Malaysian Adult Nutrition Survey (MANS) 2003, the average intake of plain water was 1.5 litres (6 glasses) for the age group between 18 to 59 years old (Norimah *et al.*, 2008).

However, the average intake of water according to the RNI and the recommendation by the Food and Nutrition Board of the National Research Council (1945) for the same age group is 7 to 11 glasses (Table 11.1). However, this recommendation includes all sources of water. After taking into account the usual intake of plain water by Malaysian (MANS, 2003) and the RNI recommendation, it is suggested that Malaysians should take 6 to 8 glasses of plain water per day.

Intake of water in special groups of people and in certain conditions such as temperature and exercise needs to be considered. Recommendation of plain water for special groups such as pregnant and lactating mothers, children and elderly should be increased according to the physiological changes and needs (Food and Nutrition Board, 1945).

Fluid intake is often inadequate in older individuals, which is due mainly to age-related decrease in total body water (relative and absolute) that makes elderly persons markedly susceptible to stresses on water balance (Ayus & Arieff, 1996). By age 75 to 80 years, the total body water content may decline up to 50 %, with further a decline in elderly women (Fulop *et al.*, 1985). Furthermore, the ability to maintain homeostasis is impaired and may increase the risk of dehydration in the elderly

(Philips *et al.*, 1984). Therefore, elderly people should be made aware of the importance of drinking enough water mainly because the sensation of thirst diminishes with age.

According to Convertino *et al.* (1996), it is recommended that individuals drink about 500 ml (2 glasses) of fluid about two hours before exercise to promote adequate hydration and allow time for excretion of excess ingested water. In the same report which referred to the athletes, it is recommended that athletes should start drinking early and at regular intervals in an attempt to consume fluids at a rate sufficient to replace all the water loss (such as sweating) or consume the maximal amount that can be tolerated. Vianna *et al.*, (2008) reported that post-exercise hydration might be beneficial for thermoregulation. In the study, they suggested that a water intake of about 500 ml immediately after 30 minutes for post-exercise hydration.

Therefore, it is recommended that the intake of water should be increased up to 500 ml (2 glasses) with increased activity and temperature.

4. Current status

In Malaysia, the Malaysian Adult Nutrition Survey (MANS) 2003 provided data on fluid consumption. Based on the study, plain water was the most consumed beverage and a majority of the population (89.7%) drank it at least six times per day. Daily average intake of plain water is 1519 ml, which is equal to 6 glasses per day (1 glass = 250 ml). Other beverages such as tea, coffee, chocolate flavoured drink and cordial in descending order, were consumed between one to two times per day. However, the data from the study only covered population

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between 18 to 59 years of age (Norimah *et al.*, 2008). Currently, there is no available data on water intake among children in Malaysia. Several studies had been conducted in other populations to determine total intake of water and beverages, especially among children (Table 11.2). In the absence of data on water intake among children in Malaysia, these data are used as basis for the recommendation on the intake.

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Table 11.1. Calculation of water requirement according to RNI for different age groups

		Energy ¹	1ml/ kcal (1945)	$\frac{1 \text{ Kcal/ 1ml}}{\text{Glass}^2}$
Children (boys)	1-3 years	980	980	3.9
	4-6 years	1340	1340	5.4
	7-9 years	1780	1780	7.1
Children (girls)	1-3 years	910	910	3.6
	4-6 years	1290	1290	5.2
	7-9 years	1590	1590	6.4
Adolescent (boys)	10-12 years	2180	2180	8.7
	13-14 years	2690	2690	10.8
	15 years	2690	2690	10.8
	16-18 years	2840	2840	11.4
Adolescents (girls)	10-12 years	1990	1990	8.0
	13-14 years	2180	2180	8.7
	15 years	2180	2180	8.7
	16-18 years	2050	2050	8.0
Men	19-29 years	2440	2440	9.8
	30-50 years	2460	2460	9.8
	51-59 years	2460	2460	9.8
	60-65 years	2010	2010	8.0
	> 65 years	2010	2010	8.0
Women	19-29 years	2000	2000	8.0
	30-50 years	2180	2180	8.7
	51-59 years	2180	2180	8.7
	60-65 years	1780	1780	7.1
	> 65 years	1780	1780	7.1
Pregnancy	1 st trimester	0	0	
	2 st trimester	360	360	
	3 st trimester	470	470	
Lactation	1 st 6 months	500	500	
	2 nd 6 months	a		

¹ Energy based on RNI for Malaysia

² 1 glass = 250ml

^a No recommendation. Energy requirement depends on amount of breast milk produced.

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Table 11.2. Daily intake of water and beverages (2 to 13 years)

Source	Focus of the study	Mean daily plain water intake		Mean total daily fluid intake	
		ml	glass	ml	glass
Bello & Hammad (2006)	Pattern of fluid consumption in a sample of Saudi Arabian adolescents aged 12 - 13 years	707 ± 167	3	1917 ± 287	7 ½
	Males	795 ± 140	3	2006 ± 256	8
	Females	614 ± 140	2 ½	1821 ± 288	7 ¼
Sichert-Hellert Kurshing & Manz, (2001)	Fifteen year trends in water intakes in German children and adolescents : Result of the Donald Study				
	Males and Females (2 - 3 Years)	175	¾	614	2 ½
	Males and Females (4 - 8 Years)	215	2	693	3
	Males (9 - 13 Years)	344	1⅓	969	3
	Females (9 - 13 Years)	298	1	823	3 ¼

* 1 glass = 250 ml

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5. Key recommendations

Key recommendation 1

Drink six to eight glasses of plain water daily.

How to achieve

1. Drink one to two glasses of plain water at breakfast and between meals.
2. Ensure plain water is available all the time.
3. Drink plain water regularly even when you are not thirsty.
4. Drink at least an extra two glasses of plain water with increased physical activity and sweating.

Key recommendation 2

Maintain fluid intake from other food sources.

How to achieve

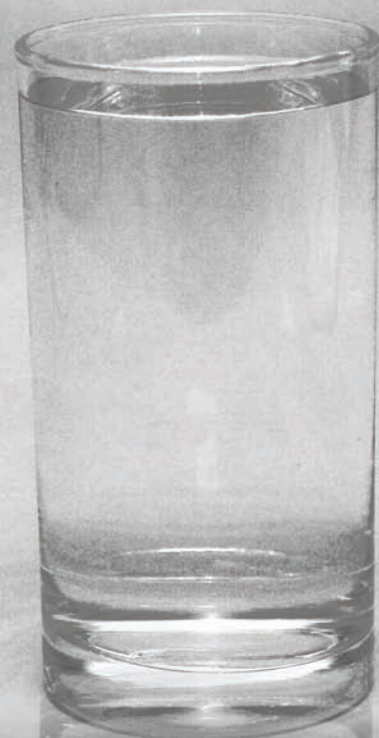
1. Continue intake of other fluid sources such as soups, beverages and juices, preferably low in fat and sugar.

Key recommendation 3

Avoid alcoholic beverages.

How to achieve

1. Choose non-alcoholic sparkling juice instead of alcoholic beverages.



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Additional recommendation: Special groups

Children

Children between two to six years old require four to six glasses of plain water since excessive intake of water may displace intake of nutritious foods and milk.

Lactating mothers

Lactating mothers need to increase water intake up to at least an extra two glasses daily.

The elderly

Remind and encourage the elderly to drink sufficient plain water. They should also be advised to continue intake of other fluid sources such as fruits and vegetables, juices and soups. Caregivers of the elderly should reassure the elderly that they can request plain water or beverages at any time.

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Appendix

Appendix 1. Dietary Reference Intake for Water

Nutrients	Function	Life stage group	AI	UL ^a	Selected food sources	Adverse effects of excessive intake	Special consideration
Water	Maintains homeostasis in the body and allows for transport of nutrients to cells and removal and excretion of waste products of metabolism	Infants	(L/d)	No. UL	All beverages, including water, as well as moisture in foods (high moisture foods include watermelon, meats, soups, etc.	No UL because normally functioning kidneys can handle more than 0.7L (24o.z) of fluid per hour ; symptoms of water intoxication include hyponatraemia which can result in heart failure and rhabdomyolosis (skeletal muscle tissue injury) which can lead to kidney failure.	Recommended intake for water are based on median intake of generally healthy individuals who are adequately hydrated ; individuals can be adequately hydrated at levels below as well as above the AIs provided. The AIs provided are for total water need; beverages (including tea, coffee, juices, sodas and drinking water) and moisture in food accounts for about 20 % of total water intake. Thirst and consumption of beverage at meals are adequate to maintain hydration.
		0 - 6 mo	0.7				
		7 - 12 mo	0.8				
		Children					
		1 - 3 y	1.3				
		4 - 8 y	1.7				
		Males					
		9 - 13 y	2.4				
		14 -18 y	3.3				
		19 - 30 y	3.7				
		31 - 50 y	3.7				
		50 - 70 y	3.7				
		> 70 y	3.7				
		Females					
		9 - 13 y	2.1				
14 -18 y	2.3						
19 - 30 y	2.7						
31 - 50 y	2.7						
50 - 70 y	2.7						
> 70 y	2.7						
Pregnancy							
14 -18 y	3.0						
19 - 50 y	3.0						
Lactation							
14 -18 y	3.8						
19 - 50 y	3.8						

Note : The table is adapted from the RDI reports. Adequate intakes (AIs) may be used as a goal for individual intakes. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender group is believed to cover the needs for all individuals in the group but lack of data prevent being able to specify with confidence the percentage of individuals covered by this intake; therefore, no Recommended Dietary Allowance (RDA) was set.

^aUL= the maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water and supplements. Due to lack of suitable data, ULs could not be established for potassium, water and inorganic sulfate. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

^bNND= Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high level intake.

Source : FNB (2004)