WATER UK

The role of tap water in public health and hydration

Version control

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This report is located at
http://www.water.org.uk/consumers/water-and-health/benefits-tap-water/report.
Please use the link for quotes and references.

For more information on the role of water in public health and to find out about Water UK and our stakeholder's activities in this area please visit the Water UK website at http://www.water.org.uk/consumers/water-and-health.

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Executive summary

This report is the first in a series of reports on the role of drinking water and the nation's health. This report explores the current landscape of the water sector, health and hydration science. Our ultimate goal is to raise awareness of the benefits of tap water for health and hydration.

Water is an essential nutrient vital for our health and hydration with several routes for consumption – from plain water, from other drinks, and from food. The body doesn't distinguish. The role of water in improving public health is important especially given the rising problems of obesity, diabetes and tooth decay as it provides a natural alternative to soft or sugary drinks.

Hydration is an important part of a healthy diet. In general, the UK population seems to be well aware of this and there is no evidence of significant dehydration amongst the general population. Whilst the general population does not show signs of significant dehydration the elderly, ill, children, and other vulnerable groups may be at risk. The risk being a prevalence towards more falls, slower recovery from illness or impaired concentration.

Water utilities in the UK provide water of the highest quality directly to our homes and offices, 24 hours a day, 7 days a week. Water utilities across the UK provide this essential service to over 64 million homes. This service is fundamental to the nation's public health.

The proportion of daily hydration achieved by tap water is significant, yet research shows that there is room for improvement especially as there is evidence that suggests a slight decrease in tap water consumption over the past decade.

Our water's quality is assured throughout the process of getting it from its source all the way to the tap. Strict regulation, comprehensive monitoring and qualified and dedicated workers provide a water quality to UK consumers that it amongst the best in the world.

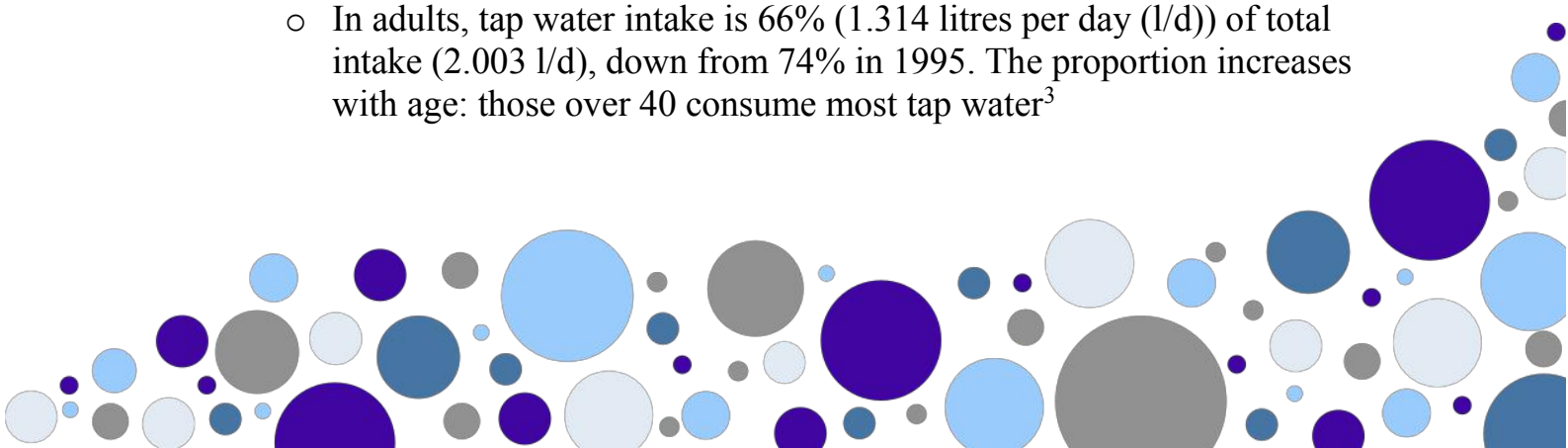
The research suggests that some consumers choose to take additional steps at home to filter tap water or use bottled water as their main source of drinking water domestically, which indicates a lack of trust, concerns over quality or cultural differences. These could readily be addressed with effective, coordinated and clear communication at both a local and regional level about the high quality of UK tap water and the benefits of drinking it.

A brief overview of the most important facts and findings

- UK water utilities provide fresh, clean tap water to over 60 million people each and every day directly to their taps
    - Tap water helps prevent obesity, diabetes, and tooth decay. It is widely affordable and so presents a healthy drink choice for everyone supplied
    - On average 150 litres is provided per person every day for drinking, cooking, washing, and sanitation
    - Water is treated to very high quality so that it is safe to drink in accordance with guidance provided by the WHO, European Commission and UK government

- 94% of people are satisfied with their water supply[8]
    - 90% of people are satisfied with the taste and smell of their tap water, up from 85% in 2011
    - One in five households filters their tap water, 13% even boil it before drinking[3]
    - Surveyed reasons for drinking tap water at home are: price (63%), convenience (45%), quality – taste/smell (39%)[2]
    - 77% judge bills as affordable[8]
    - Only 16% of complaints to CCWater concern tap water quality[8]
    - Rare cases of quality failures are mostly due to consumer taps. Responsibility for their maintenance lies with homeowners but 28% of them are unaware of this duty, up from 24% in 2013[8]

- Tap water is a significant source of hydration for the population:
    - Babies under 12 months get 81% of their liquids (excluding breast milk) from tap water[4]
    - Children aged 0-15 have 53% of their daily liquids covered by tap water[4]
    - In adults, tap water intake is 66% (1.314 litres per day (l/d)) of total intake (2.003 l/d), down from 74% in 1995. The proportion increases with age: those over 40 consume most tap water[3]



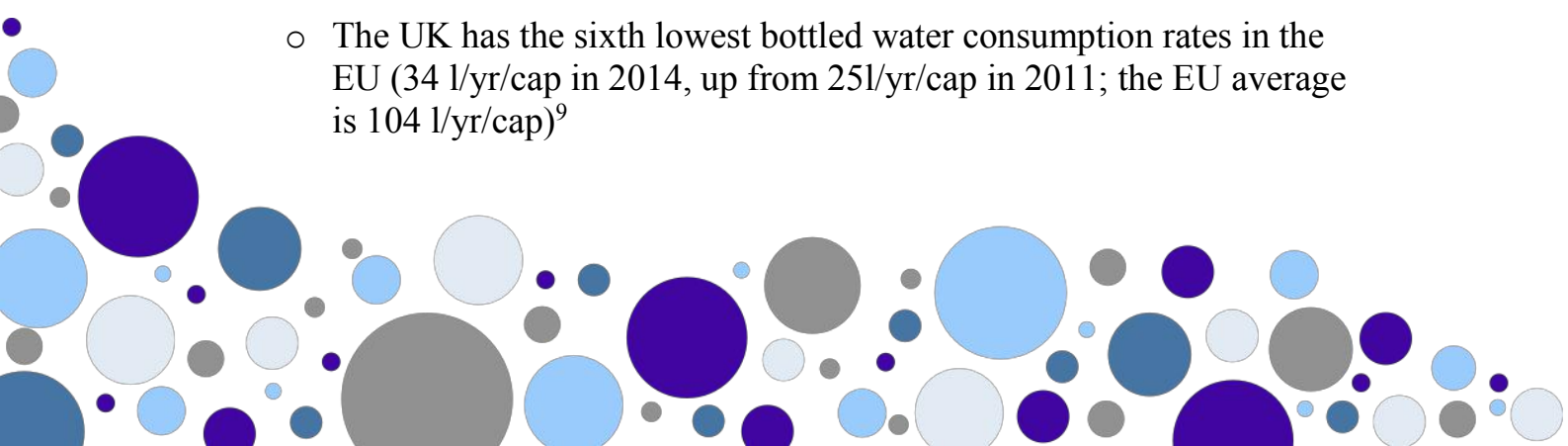
  - The values above comprise plain tap water, boiled tap water for tea and coffee, as well as squash

- Of all beverages, the most popular drinks in 2008 were: tap water (86% of respondents drink it), tea (79%), fruit juice (79%), coffee (70%), squash (70%) and fizzy drinks (63%)[3]
  - More recent data suggests that 78% of people drink tap water at home and 51% when at work[2]

- There is an apparent trend towards healthier drink choices
  - 30-40% of people drink more water than they did five years ago
  - 22-29% said they drink less spirits, beer, fizzy drinks and instant chocolate[3]

- Hydration on the go is not a big market in terms of volume
  - Only 1.3% of all drinks were reportedly consumed on a journey[3]
  - On the other hand, 28% of people who usually drink tap water blame lack of easy access for their decision to purchase bottled water when out and about[2]

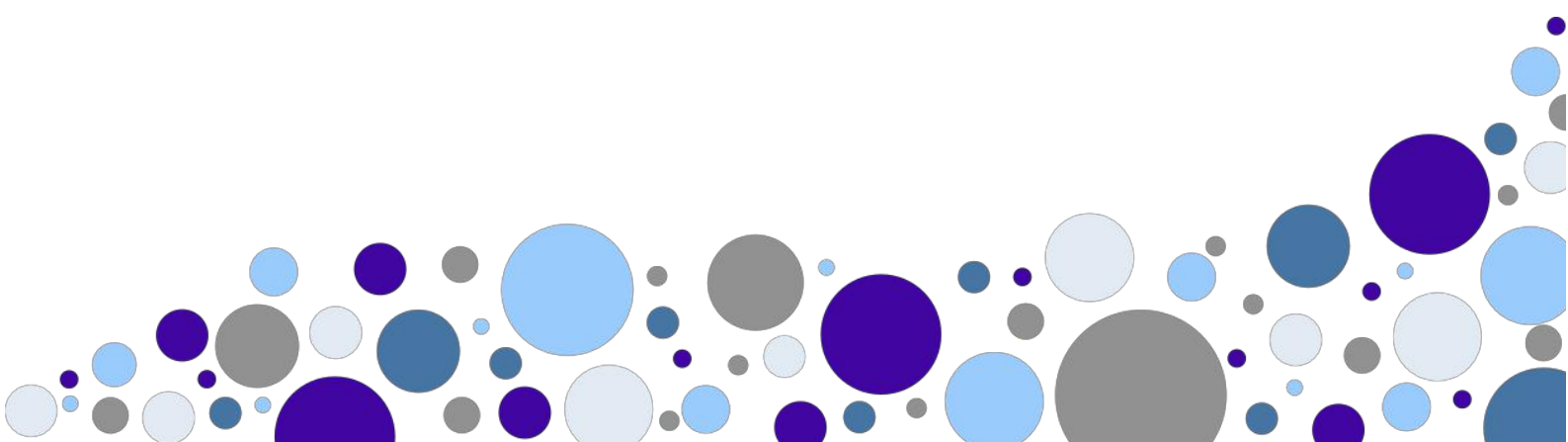
- 45% of households (also) drink bottled water, up from 30% in 1995[3]
  - Only 8% of people usually prefer bottled water to tap water at home but this goes up to 24% at work and 48% when on the go[2]
  - From the 8% who drink bottled water instead of tap water at home, most stated reasons are poor quality in terms of taste and/or smell (43%), undesirable content (30%), concerns about safety (24%), convenience (20%), and poor quality in terms of appearance (20%)[2]
  - The reported reasons for drinking bottled instead of tap water when out and about are lack of easy access (28%), concerns about cleanliness of public taps (19%), logistics of reusable bottles (19%), convenience (19%)[2]
  - The UK has the sixth lowest bottled water consumption rates in the EU (34 l/yr/cap in 2014, up from 25l/yr/cap in 2011; the EU average is 104 l/yr/cap)[9]



  - It is unclear to what extent bottled water acts as a substitute for drinking tap water[3]

- Restaurants and bars that sell alcohol are obliged to serve tap water for free
  - 1 in 5 citizens are unaware of this rule[2]
  - 32% of people usually drink tap water in cafes and restaurants; this decreases with age[2]
  - Restaurants and institutions have seen a rise in tap water demand[9]

- The British Nutrition Foundation concluded that "it is not meaningful to give a specific recommendation regarding water requirements, as these vary widely"[18]
  - Individual factors such as age, gender, body mass, environmental conditions and the changing physical activity play role
  - Water from foods and beverages can meet fluid needs just as plain water; there is no qualitative difference[16]
  - Food and metabolic oxidation cover around 20% of the total daily fluid intake, depending on the diet[18]
  - There is consensus on the need to maintain an input-output fluid balance
  - EFSA settled on Adequate Fluid Intakes (AIs), which are based on observed intakes and on desirable urine osmolality. AIs for females were set at 2.0 l/d and for males at 2.5 l/d. These AIs apply to conditions of moderate environmental temperature and moderate physical activity[27]
  - The NHS advises people to drink about 1.6-2 litres of fluids a day to avoid dehydration[36]



1. Introduction

Drinking water, provided to consumer taps from the water companies in the UK, is a vital service and a matter of public health. Since privatisation in England and Wales in 1989, the majority of UK consumers are supplied by privately owned and operated companies overseen by independent economic and quality regulators. The private companies in England and Wales and the public companies in Northern Ireland and Scotland have proven to be greatly efficient in delivering affordable and reliable access to high quality drinking water. 99% of the population of England have access to a public mains drinking water supply which routinely exceeds quality standards set by the WHO, European Commission and UK government.[1]

This report is intended for water, nutrition and policy professionals. It explores the current landscape of the water sector in relation to health and hydration. It summarizes the latest research data, survey results and scientific evidence on the role of water in public health and hydration. The report aims to highlight what's currently working well and how the water sector could improve its communication in order to strengthen the positive impact that tap water has on hydration and health.

2. Tap water consumption data

Tap water is readily available – especially at home or at work – so whether people drink it or not is a matter of mere choice; a luxury desired by many around the globe yet often taken for granted in the developed world.

CCWater commissioned a study in 2015 to find out consumers' most recent attitudes to drinking tap water. The number of adults who drink tap water at home is reported to be 78% (as opposed to 86% in 2008 – see Table 9). The proportion usually drinking tap water falls to 51% at work, as shown in Figure 1.

When out and about, most people drink bottled water (48%). In cafes and restaurants, 36% of respondents order a drink other than water but 32% said they usually drink tap water.[2] Hydration on the go is discussed in more detail in chapter 7 on page 19.

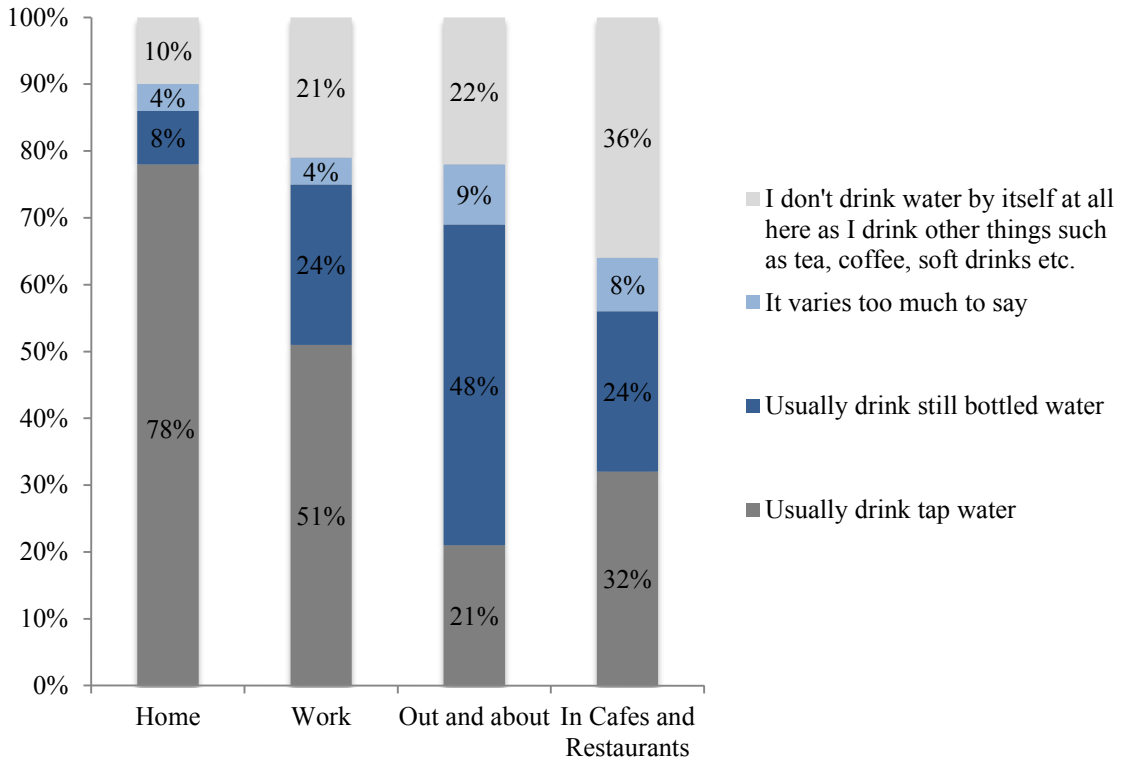


Figure 1: Attitudes to tap water in England and Wales, a 2015 study commissioned by CCWater[2]

A 2008 DWI[3] study found that the arithmetic mean of the total daily liquid consumption, using weighted data from phase two (summer), is 2.003 l/d compared to 1.931 l/d in phase one (spring). The arithmetic mean of tap water consumption in phase two was 1.314 l/d compared to1.275 l/d in phase one. That means that the adult intake of tap water in this study was 66% of total liquid intake. This falls within the range found by previous studies, which stated 74% for 1995 and 54% for 1978.

Note that these volumes include tap water drunk as squash and boiled tap water drinks like coffee and tea, which is the most commonly consumed drink amongst all the age groups above 24.[3] When it comes to plain water, 60% of people drink one glass or less a day.[10]

The proportion of tap water in drinks increases with age. Those over 40 consume the most tap water, while the youngest age group (16-25) consumes the least – see Table 1.

As with the two previous studies of 1978 and 1995, the DWI[3] 2008 survey has shown that men drink more liquids overall (including alcohol), but women drink more tap water – see Table 2.

		Total liquid lpd		Tap Water lpd		% Tap Water		Total Population
		1995	2008	1995	2008	1995	2008	2007 (m)
W1	16-24	1.58	1.90	0.974	1.034	62	54	5.678
W2			2.11		1.12		53	
W1	25-39	1.709	2.021	1.238	1.256	73	62	15.168
W2			2.079		1.315		63	
W1	40-54	1.802	2.042	1.385	1.411	77	69	9.850
W2			1.955		1.441		72	
W1	55+	1.698	1.819	1.353	1.322	80	73	10.858
W2			1.965		1.447		74	

Table 1: Average daily consumption of liquids in 1000 British households[3]

		Total liquid lpd			Tap Water lpd			% Tap Water		
		1978	1995	2008	1978	1995	2008	1978	1995	2008
W1	Male	2.045	1.617	1.946	1.115	1.127	1.207	55	70	62
W2				2.097			1.303			62
W1	Female	1.544	1.515	1.767	1.288	1.149	1.282	83	76	73
W2				1.892			1.322			70

Table 2: Average consumption of liquids in 1,000 British households per day according to gender, DWI[3]

Interestingly, CCWater claims that adults of a higher social classification (ABC1) are more likely to usually drink tap water than those with a lower social profile (C2DE). This is the case at home, at work and in restaurants. The DWI[4], on the other hand, found that *"there were no significant differences in the mean volume of tap water consumed by social grade"* in children. The discrepancy might be explained by the different demographics, but it could also be caused by different methodologies: CCWater had no quantitative questions.

To elaborate on demographics, CCWater[2] pointed out that customers aged 45+ were least likely to ask for tap water in restaurants. Younger people, aged 18-24 (52%) and 25-34 (54%), were more likely to cite the convenience of tap water as a reason to drink it at home than older people aged 45-54 (42%) and 55+ (39%). A 2012 DWI study[4] of the hydration habits of those aged 0-15 found that 53% of the total daily liquid consumption was accounted for by tap water. This figure is even higher (81% excluding breast milk) for babies under 12 months.

As concerns hydration of children, it is interesting to note that new School Food Standards[5] require schools to offer free, fresh drinking water at all times. No study has been written (yet) as to whether this measure increases water consumption among children or not but it is seen as a positive step towards healthy hydration of the youngest generation.

3. Positive perceptions of tap water

The frequency and volume of tap water consumption is driven by a number of factors. The most recent CCWater survey, captured in Figure 2, indicates that good value and convenience are the most dominant ones.

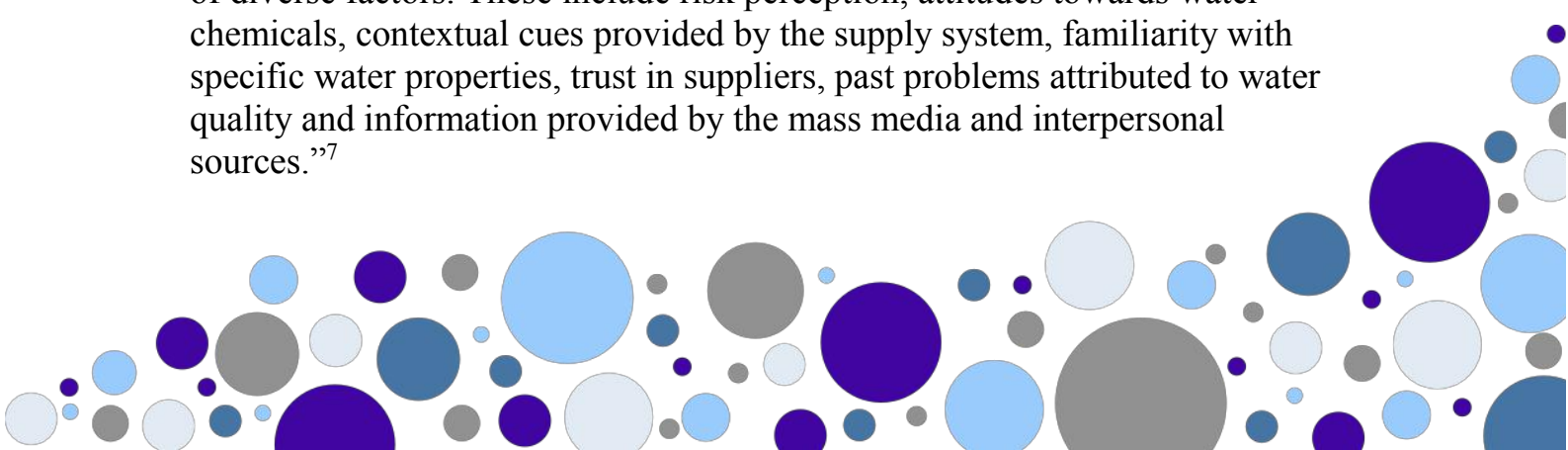
Another survey emphasized consumers' satisfaction with prices: 75% of them rated their water supply services as good value. To put local prices in perspective, Table 3 lists water charges in other European countries. Charges in England and Wales compare to Dutch and Belgian prices, while the Danish pay significantly more for their supply. On the other hand, Switzerland, Spain, Austria, and Bulgaria charge relatively less for a cubic metre (measured against GDP per capita).

All values in £	Austria	Belgium	Bulgaria	Denmark	Switzerland
GDP per capita	27 690	24 570	9 360	24 570	29 900
Average Annual Charge AAC 100 m3	357	367	122	656	382
AAC per GDP	1,29%	1,49%	1,30%	2,67%	1,28%
	France	Netherlands	Poland	Spain	England & Wales
GDP per capita	23 205	26 910	13 715	19 565	24 245
Average Annual Charge 100 m3	322	466	184	195	391
AAC per GDP	1,39%	1,73%	1,34%	1,00%	1,61%

Table 3: Water charges in selected European countries[6]

To continue with reasons for drinking water at home from Figure 2, quality comes third after good value and convenience.

UNESCO stated that perceptions of quality "result from a complex interaction of diverse factors. These include risk perception, attitudes towards water chemicals, contextual cues provided by the supply system, familiarity with specific water properties, trust in suppliers, past problems attributed to water quality and information provided by the mass media and interpersonal sources."[7]



The reported perceptions of British tap water vary. Overall, there is respectable satisfaction with tap water quality and Figure 3 gives some proof. It shows that the vast majority of studied households have not had any problems with the quality or appearance of tap water in the preceding 12 to 18 months. Moreover, Table 4 indicates that consumers are reporting fewer problems than they did in 1995.

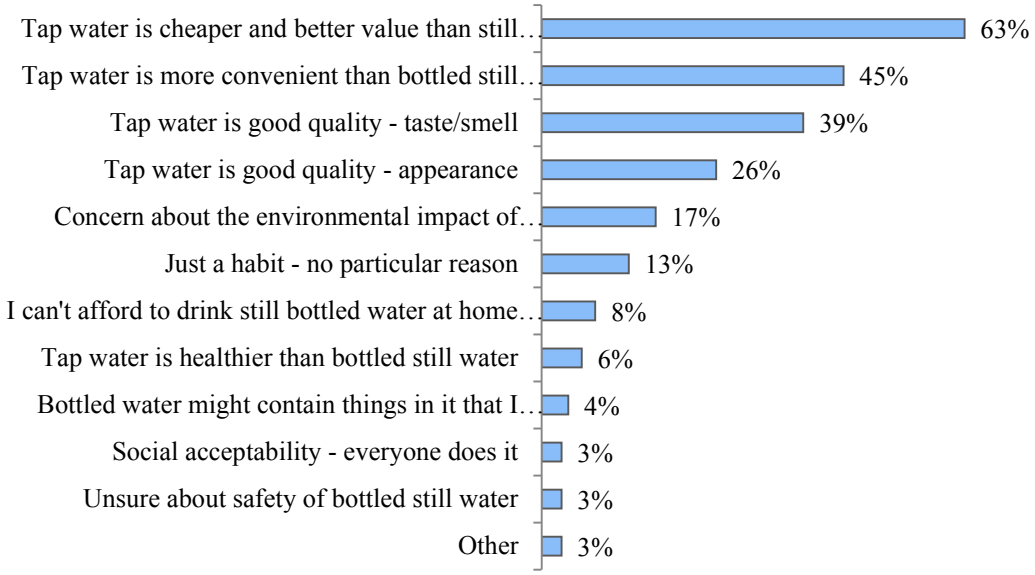


Figure 2: Surveyed reasons for drinking tap water at home[2]

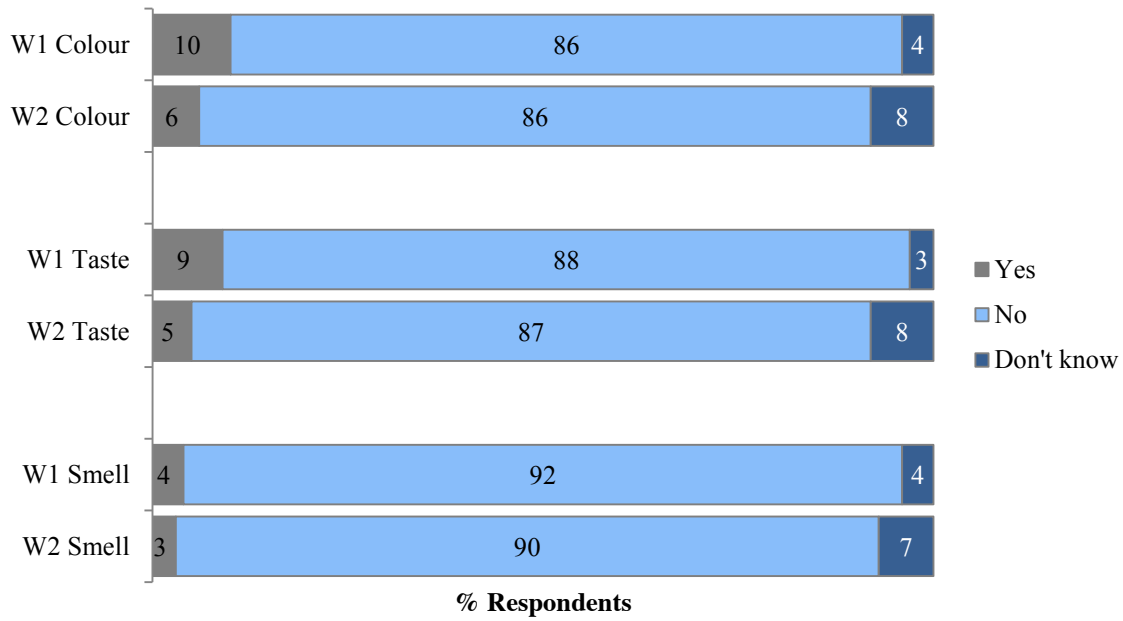


Figure 3: Concerns or problems with tap water, a DWI[3] survey of 1,000 households

On the other hand, Figure 2 shows that consumers are less appreciative or perhaps less aware of their tap water quality than water companies might expect in that they don't perceive quality as a major reason for drinking tap water.

In 2014, test results from across the UK showed compliance rates of nearly 100%. Rare cases of quality failures are mostly due to consumer taps. Responsibility for their maintenance lies with homeowners but 28% of them are unaware of this duty, up from 24% in 2013.[8]

	Had a problem					
	1995		2008			
			Wave 1		Wave 2	
	n	%	n	%	n	%
Smell	46	9	40	4	26	3
Taste	96	18	85	9	50	5
Colour	102	20	95	10	61	6

Table 4: Comparison between 1995 and 2008 of those who had problems with drinking water (n= number of households), DWI[3] report

CCWater surveys reveal that there is overall satisfaction with tap water. The most recent on[8], published in August 2015, states that:

- 94% of people are satisfied with their water supply, up by one percent from 2013
- 90% of people are satisfied with the taste and smell of their tap water, up from 85% in 2011 (yet only 39% of people see this as a reason to drink it as explained earlier)
- The downward trend seen since 2010 in satisfaction with value for money of water services has been reversed, with three-quarters (75%) of customers now being satisfied (up from 69% in 2013)
- Perceptions of fairness are now at 68%, up from 54% in 2013. This follows a sharp fall from 2012 to 2013
- Agreement that bills are affordable is now 77%, up from 67%. Perceptions of affordability and fairness are the highest since this survey began in 2006

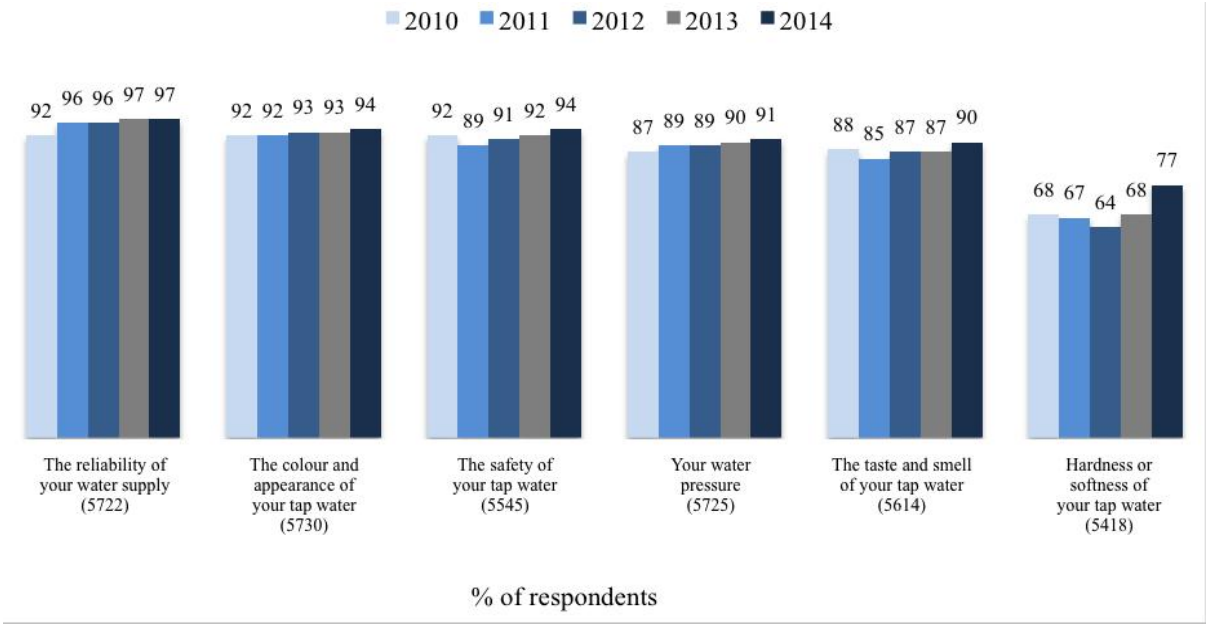


Figure 4: Customer satisfaction with aspects of the water supply service[8]

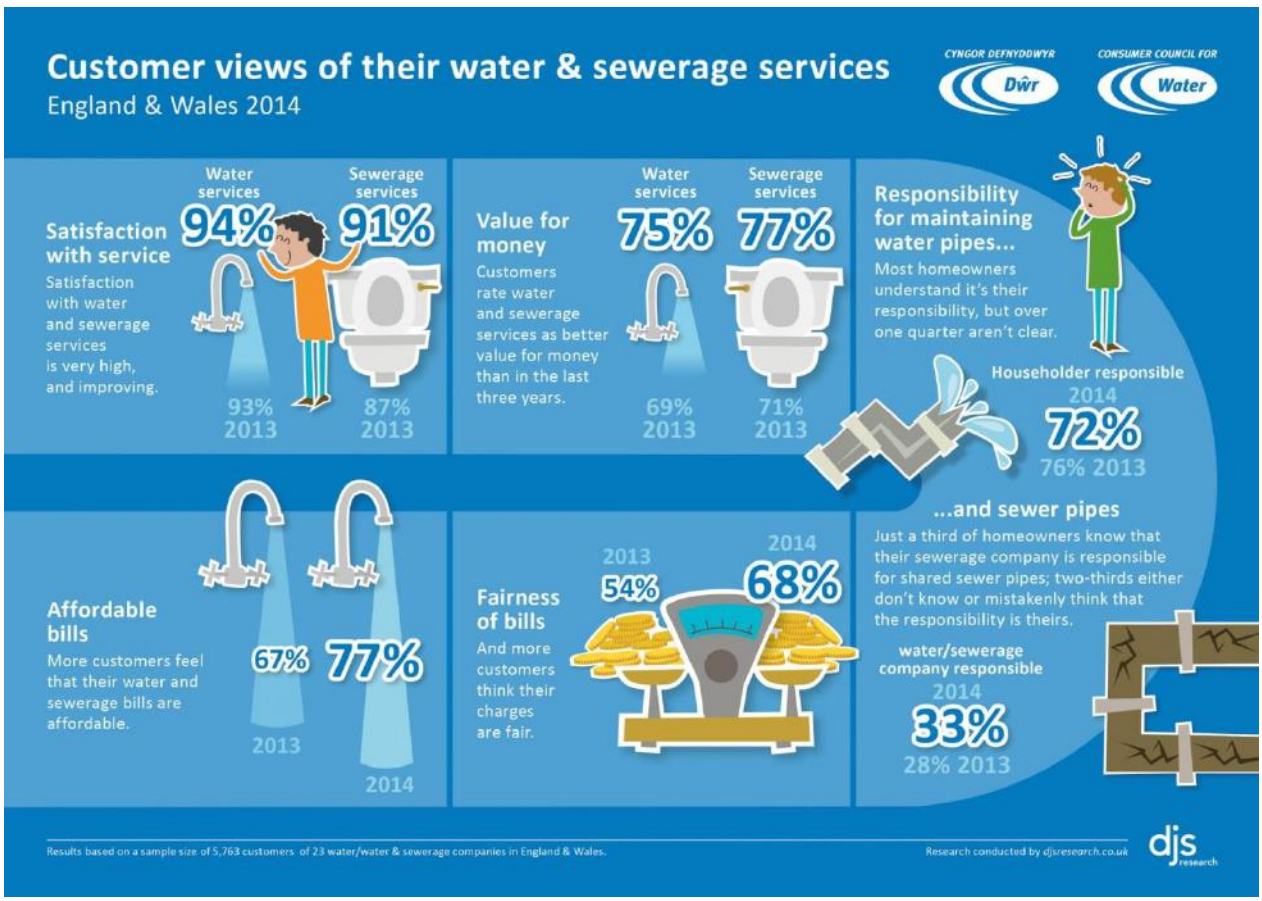


Figure 5: Infographic with results of a national survey commissioned by CCWater (5,763 interviews carried out between 11/2014-02/2015)[8]

It is evident that, compared to other features of water provision, customers do not find the quality of their water an issue. CCWater reports that 52% of all complaints received fall under billing and charges, while water as such is the subject of only 16% of all complaints and 13% of all enquiries (data for 2014). Overall, customer complaints about water companies increased by 2% from 9,957 in 2013-14 to 10,138 in 2014-15.[8]

All major findings of this report are highlighted in Figure 5 above. Figure 4 then takes a closer look at customer satisfaction with different aspects of water supply. All categories see an upward trend. Hardness and softness is of most concern, especially in England (76% are satisfied compared to 94% in Wales).[8]

4. Tap water concerns

This section looks at the negative perceptions of tap water and helps to point out which unjustified concerns are most prevalent and who can be targeted with accurate information.

From a nutritional point of view, tap water and bottled water can be seen as alike.[19] It is therefore interesting to see that consumers often differentiate strongly between the two. CCWater[2] recently revealed some of the links between bottled water consumption and attitudes to tap water. Unpleasant taste and/or smell were the most cited reasons for drinking bottled water instead of tap water at home (8% of consumers belonged to this category as shown in Figure 1). Older people are more likely to report that aesthetic flaws of their tap water (e.g. its taste, smell and appearance) make them drink bottled water at home.[2] Fear and concerns play a role in most reasons given. Figure 6 quantifies all reasons surveyed.

One of the trends indicating a flawed perception is the rise of home-filtering devices. “There has been a significant increase since 1995 in the proportion of people who own water filtering jugs, as well as a significant decrease in those who own soda stream type appliances.” While 18% of respondents filter their water (compared to 9% in 1995), 13% even boil it before drinking.[3]

Table 5 and Table 6 summarise in-house treatment behaviours. In terms of a regional analysis, the East Midlands and Eastern regions show ownership of filtering jugs as most prevalent.
The statistics indicate an increase in the use of jug filters and a decrease in the use of water for preparing drinks. In 1995, a total of 99% of households reported tap water as their source for making drinks. In 2008, the figure decreased to 97%.[3]

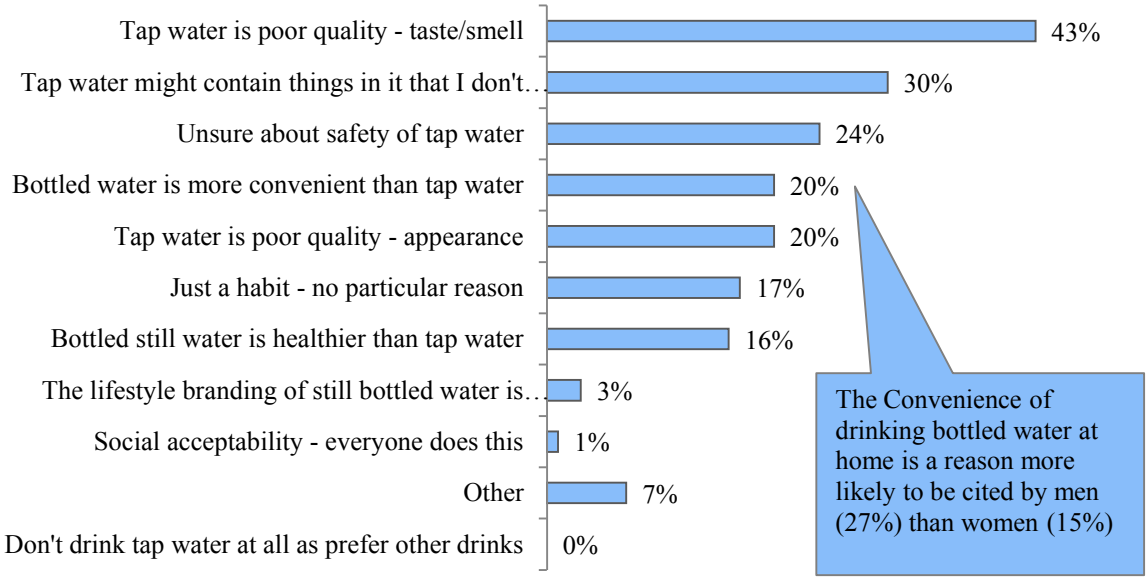


Figure 6: Top 3 reasons why 8% prefer to drink bottled rather than tap water at home[2]

	1995 %	Wave 1 %	Wave 2 %
Water filtering jug	12	24	19
Cold water dispenser in fridge	9	7	4
Plumbed in special water filtering tap	2	3	2
'Teas-made' machine	8	2	1
Soda stream or other fizzy drinks maker	10	2	1
Water softening device eg a 'Permutit'	1	2	1
Bottled water cooler machine	1	1	1
Other	2	1	0
Base	**476**	**992**	**1002**

Table 5: Ownership of tap water preparation devices, a comparison of 1995 and 2008[3]

Treatment Process	Wave 1 %	Wave 2 %
Filter the water	18	18
Boil the tap water (allowing it to cool before using it)	13	12
Use sterilising tablets	8	8
Put it into a special fridge water dispenser	7	7
Any other treatment	3	5
None of the above	74	76

Table 6: Treating tap water – household habits of 2008, DWI[3]

5. Bottled water consumption and trends

As far as health and hydration are concerned, tap water and still bottled water are not significantly different as both come without calories and sugars. This section provides a brief overview of the bottled water market in the UK.

UK consumers drink close to 1.4 billion litres of still bottled water a year, which presents 71% of the bottled water market. Other categories are flavoured bottled water (16%), carbonated bottled water (12%), and functional bottled water – i.e. with added ingredients, such as vitamins, minerals, or oxygen (1%). Some 90% of the still bottled waters purchased are mineral and spring waters. Table water (i.e. often bottled tap water) is much less popular.[9]

The popularity of still bottled water is demonstrated by a 14% increase in consumption between 2009 and 2014. [9]

Off-trade sales are growing thanks to the marketing of the perceived benefits and convenience of bottled water. Consumers are "*seeking healthier and more natural sources of hydration and many try to increase their water consumption while on-the-go. Growth is also being driven by consumers who create their own fizzy drinks: mixing juice or fruit with carbonated bottled water, supporting a strong 10% off-trade volume growth in this area*".[9]

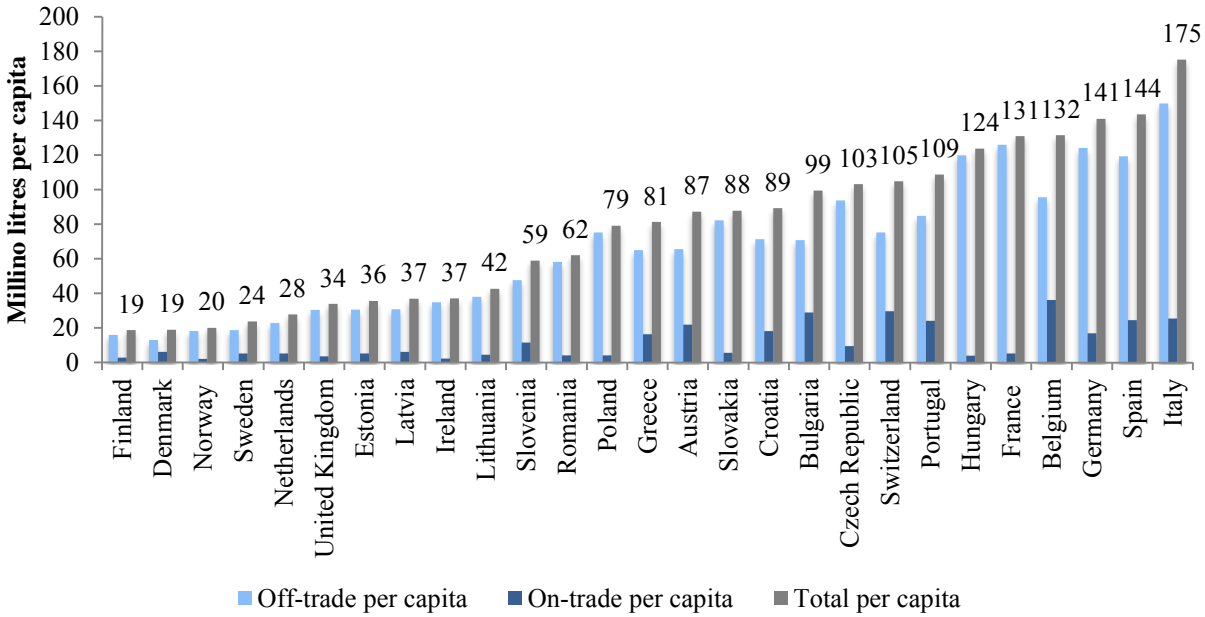


Table 7: Per capita 2014 consumption of bottled water of most EEA countries[9]

To provide some international context, Table 7 compares the UK with other European countries in terms of bottled water consumption. In 2014, the UK (34 l/yr/cap, up from 25l/yr/cap in 2011) was well below the EU average (104 l/yr/cap, same as in 2011) and had the sixth lowest bottled water consumption among 27 EU countries.

The DWI[3] looked more closely at British bottled water preferences and found that in summer 2008, a total of 46% of households used bottled water for drinking, compared to 44% in spring and 30% in 1995.

Fewer than one in ten (8% in phase one and 7% in phase two) consumed sparkling water – half the proportion favouring sparkling in 1995.[3]

A total of 46% of the 1,000 households surveyed said that they used bottled water for drinking, which is a sharp rise from 30% in 1995. It is not clear whether this is instead of drinking tap water or in addition to drinking it (hence instead of other drinks than water because total liquid intake remains similar).

It's difficult to determine to what extent the consumption of bottled water is a substitute for drinking tap water.[3] Some surveys have shown that people are usually either tap water drinkers or bottled water drinkers.[10] **Figure 6** indicates that this is especially true at home: those who buy bottled water for their households do so mainly because of fears related to tap water. Preferences for drinks at work, in restaurants or when out and about are less explained.

6. Beverages other than water and their relation to healthy hydration

While bottled water is the closest alternative to tap water, it is not the most consumed beverage type. Within the packaged segment, soft drinks have been around the longest.

To provide a holistic summary, Table 8 shows how popular each beverage category is among UK households.

According to the data in Table 8, the most popular drinks are: tap water (86% of respondents drink it), tea (79%), fruit juice (79%), coffee (70%), squash (70%) and fizzy drinks (63%). What's optimistic is that 3 out of five people said they drink more water than they had done 5 years ago.

Drink type	Do you drink				Trends over seasons									Trends in last 5 years								
	Yes %		No %		More in summer %			More in winter %			Same all year %			More nowadays %			Less nowadays %			About the same %		
	Ph1	Ph2	Ph1	Ph2	Ph1	Ph2	1995	Ph1	Ph2	1995	Ph1	Ph2	1995	Ph1	Ph2	1995	Ph1	Ph2	1995	Ph1	Ph2	1995
Plain tap water	86	86	13	13	49	50		1	0		49	49		30	33		5	5		62	61	
Bottled still water	53	61	44	37	57	56	50	1	0	1	40	43	49	36	39	40	9	5	8	52	54	51
Bottled sparkling water	19	24	77	72	47	45	41	1	0		52	54	59	38	32	36	11	9	5	51	57	59
Tea	79	78	18	19	3	4	5	19	16	18	77	79	77	15	13	17	7	8	8	76	77	75
Coffee	70	69	26	26	2	1	2	17	16	19	79	81	79	14	14	14	15	14	13	69	71	73
Instant Chocolate	38	35	59	61	1	2		63	63		35	33		10	10		23	21		65	67	
Cup-a-Soup	33	32	63	63	1	1		69	71		29	26		17	11		20	19		61	67	
Savoury (eg Bovril)	12	8	84	85	0	2		63	75		35	22		14	14		23	20		58	64	
Squash	70	69	28	28	60	61	67	0	0		38	38	33	20	23	16	11	8	11	67	67	73
Beer/lager/cider	58	59	39	36	34	35		1	1		65	61		12	10		26	26		60	61	
Wine	56	58	42	38	15	17		3	4		80	77		17	17		16	19		64	62	
Spirits	42	43	55	52	10	9		11	11		79	78		12	10		29	25		58	63	
Fruit Juice	79	77	19	19	34	31		1	1		65	67		17	20		7	6		74	71	
Fizzy drinks	63	62	34	31	36	34		1	0		63	64		8	13		22	16		68	69	
Milk	59	55	39	40	4	5		6	6		89	88		6	6		10	12		81	81	
Ready prepared soups	40	36	57	57	1	1		67	70		31	29		9	10		13	16		76	72	
Milkshake/yoghurt drinks	32	30	66	64	28	24		2	1		69	74		18	16		16	16		65	68	

Table 8: Seasonal and temporal trends in consumption of drinks[3]

While Table 8 lists what types of beverages people drink, it doesn't quantify their volumes. Kantar Media have recently surveyed the British public to find out which drinks were consumed at home. Tea and coffee made up 53% of all the volume, tap water 15%, squash and juice 14%, and alcohol 6%.

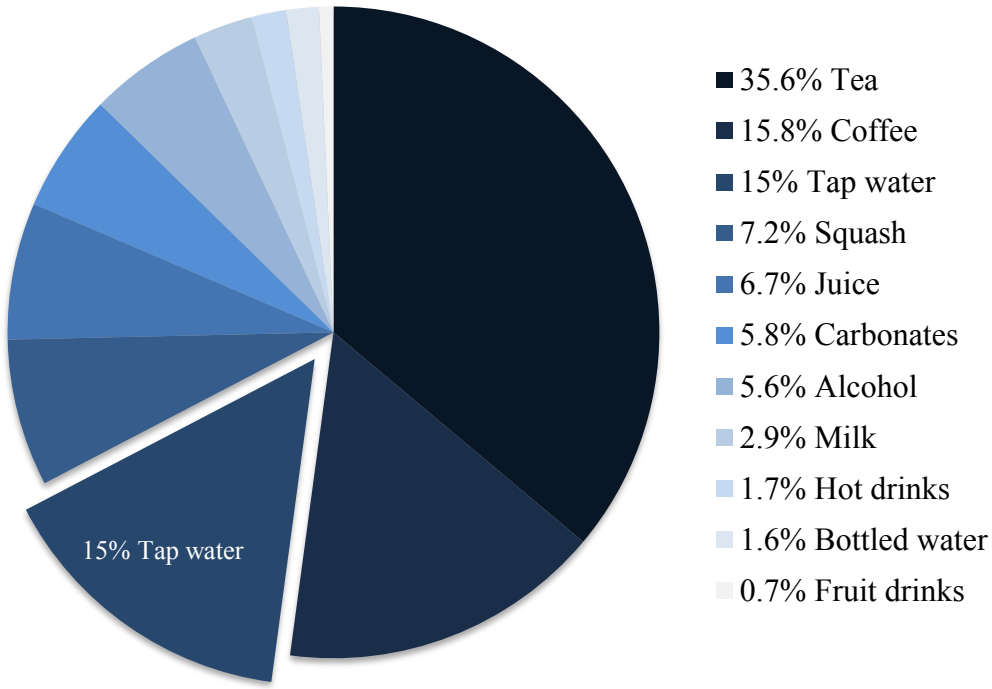


Figure 7: Proportion of beverages consumed in UK homes. Courtesy of the Natural Hydration Council[10]

In terms of health, tea and coffee – if consumed with none or little milk and none or very little sugar – have the same hydrating effect as water, deliver trace amount of calories and contain small amounts of nutrients (i.e. potassium and phosphorus).[19]

If drank in moderate volumes (less than 1.8l of tea a day and less than 1.2l of instant coffee a day), the diuretic effect of caffeine/theine doesn't cause dehydration.[19] Generally speaking, tea and coffee don't present a challenge for public health and as such aren't of particular interest to the water companies. The only relevant viewpoint is that both will mostly be prepared with tap water.

Squash, carbonates, and also juices on the other hand may be a significant source of sugar. Their relative acidity also increases the risk of dental erosion if consumed too often. The specific risks always depend on composition (e.g. sugar and calorific content) and frequency of consumption.[19]

In terms of age, there is considerably more popularity of fruit juice, fizzy and soft drinks in the 16 to 24 age group compared to the other age groups.[3] Sugary drinks have been named as the largest source of sugar in school-age children and Public Health England advises that sugary drinks have no place in a child's daily diet and should be swapped to water, lower fat milks, sugar free, and no-added sugar drinks instead.[12] The new School Food Plan reflects this advice.[5]

Alcoholic drinks vary in their ethanol and water content. Ethanol (alcohol) has a diuretic effect, so consuming strong drinks such as wine and spirits without additional fluids can cause dehydration.[19] Moreover, ethanol has the second greatest amount of calories per mass, 6.9 kcal/g.

Figure 8 summarizes disadvantages and benefits of all main beverage categories.

Beverage	Advantages	Disadvantages
Drinking water	Provides water without additional energy.	May not be sufficient for rehydration during or after intense exercise undertaken for more than 40 minutes–1 hour.
Tea	Provides water, some nutrients (especially if consumed with milk) and plant bioactives. Contains a small amount of energy. May help reduce risk of cardiovascular disease.	May increase risk of low iron status in at-risk groups if consumed with meals. Contributes to caffeine intake, which may be an issue for some consumers.
Coffee	Provides water, some nutrients and plant bioactives.	May lead to high caffeine intakes if caffeinated varieties are over consumed.
Fruit juice/smoothie	Provides water, and some vitamins and plant bioactives. Smoothies may provide fibre.	High natural-sugar content and, hence, energy content. May increase risk of dental caries and dental enamel erosion if consumed frequently between meals.
Milk	Provides water and a rich source of nutrients.	Source of saturated fatty acids.
Soft drinks	Provide water.	Sugar-sweetened versions have a high energy content. May increase risk of dental caries and dental enamel erosion if consumed frequently between meals.
Sports drinks	Some provide optimal amounts of sodium and carbohydrate for those performing intense exercise.	Moderate sugar and energy content, and not necessary for sedentary people or those doing moderate exercise.
Alcohol	More dilute alcoholic beverages such as beer, cider or shandy provide some water. Moderate alcohol consumption may have cardiovascular benefits for middle-aged and older adults.	Concentrated alcoholic beverages (*i.e.* wine and spirits) are dehydrating. Excessive consumption of alcohol is detrimental to health. Relatively high energy content and promotes overconsumption of energy. Some alcoholic beverages, particularly white wine, can contribute to dental erosion.

Figure 8: The advantages and disadvantages of beverages for health[19]

The most pressing concerns in relation to beverages are their calorific content and their impact on dental health, namely dental caries and dental erosion. Benelam and Wyness explain both problems: *"Dental cavities are caused by a reduction in pH due to bacterial fermentation of carbohydrates, and so the frequency of consumption of drinks containing sugars is a concern for risk of caries. Dental erosion occurs at a lower pH and is caused by the consumption of acidic foods and drinks, in particular, citrus juices and soft drinks containing acids."*[19]

There is a strong and growing focus on soft drinks with reduced sugar content, both for adult-focused and child-focused products. This results from a growing national concern about weight levels, with 27% of adults obese in 2014 and 38% overweight.[9] Levels are also rising among children, with a third of 10-11 year-olds and over a fifth of 4-5 year-olds being overweight or obese in 2013/2014 according to The National Child Measurement Programme.[11]

Treating obesity and its consequences alone currently costs the NHS £5.1bn every year. The Scientific Advisory Committee on Nutrition (SACN) has concluded that the recommended average population maximum intake of sugar should be halved: it should not exceed 5% of total dietary energy. SACN also recommended that consumption of sugar-sweetened drinks should be minimised by both adults and children.[12]

Many consumers are keen to reduce their sugar consumption. There is also a general trend towards more natural and healthier choices: 30-40% people drink more water (both tap and bottled) than they did five years ago; 22-29% said they drink less spirits, beer, fizzy drinks and instant chocolate.[3] The soft drinks industry confirms this trend by reporting only slight volume growths.[9]

Euromonitor International elaborates on the decline of sugary drinks: *"Similarly, sports drinks were hit by media reports encouraging consumers to switch to water when exercising or to create their own homemade sports drinks containing water, juice and salt or electrolyte powder.*

A number of niche products are seeing dynamic growth, with coconut water in juice for example benefiting from its low-sugar and high-electrolyte content. Among flavoured bottled waters, the leading flavours are lemon and lime, blackcurrant, summer fruits and strawberry".[1]

7. Where beverages are consumed

People drink mostly at home or at work/school but also when out and about. Table 9 shows that hydration on the go is not a big market, however. Only 1.3% of all drinks (calculated from W2 of the table) were reportedly consumed when out and about. The majority were consumed at home, with some two-thirds or more of the specified drink categories being drunk at home. The exceptions again are fizzy drinks and alcohol.

The other main location where drinks are consumed is work, with some 10-20% of drinks consumed there. Euromonitor International research suggests that tap water has become a popular choice for employers: "[there has been] growing focus on the environmental impact of bottled water, with many employers thus instead encouraging consumers to drink tap water. This approach also inevitably offers cost-savings for employers, with many businesses thus grateful to have an environmental excuse for the removal of water dispensers."[9]

An interesting observation made by other studies is that 75% of fluid intake occurs while eating.[19] This corresponds to the fact that most drinks are consumed at home and at work.

		Coffee %	Tea %	HMD %	Fruit juice %	Soft drink %	Fizzy drink %	Alcohol %	Water based food %	Other %
Home	W1	68	77	77	74	70	52	48	69	63
	W2	**67**	**77**	**79**	**73**	**68**	**52**	**50**	**70**	**68**
Work	W1	19	14	10	10	16	18	0	17	15
	W2	**20**	**14**	**8**	**13**	**19**	**20**	**1**	**19**	20
Friends/ Relatives	W1	7	6	3	5	4	6	8	6	2
	W2	**7**	**5**	**4**	**5**	**5**	**7**	**10**	**4**	**3**
Shop/Cafe	W1	3	1	6	4	1	7	1	3	4
	W2	**3**	**1**	**5**	**2**	**2**	**6**	**0**	**2**	**1**
Bar/Pub	W1	0	0	1	2	1	7	41	1	1
	W2	**0**	**0**	**0**	**1**	**1**	**5**	**36**	**1**	**0**
On journey	W1	0	0	1	2	3	6	0	2	8
	W2	**0**	**0**	**1**	**3**	**2**	**7**	**0**	**1**	**3**
Other	W1	1	1	1	2	2	3	1	2	5
	W2	**1**	**1**	**2**	**1**	**2**	**3**	**2**	**2**	**3**
Base	W1	16,544	24,869	1,947	3,743	15,455	4,226	7,018	1,006	1,376
	W2	**10,637**	**22,928**	**1,470**	**3,806**	**16,995**	**4,354**	**7,093**	**849**	**5,767**

Table 9: Which drinks and where they are consumed – a survey of 1000 British households, DWI [3]

Several reasons are given for low consumption of tap water on the go. Convenience is commonly cited as an issue, especially for those of a higher social grade (see Figure 9) who are more likely to report that they 'can't quite get organized to carry tap water around with them in a reusable bottle' – 22% of ABC1s compared with 15% of C2Des.[3]

Easy access to drinking water is more of an issue for young people than for older people, with 42% of 18-24s citing this as a reason compared with 26% of those aged 35-44, 22% aged 45-54 and 26% of those aged 55+.

Residents of London are much more likely than residents of other regions to report that they lack easy access to drinking water when out and about.[2]

As we saw in Figure 1 on page 5, most people drink bottled water (48%) when out and about. In cafes and restaurants, 36% of respondents order a drink other than water but 32% said they usually drink tap water.[2]

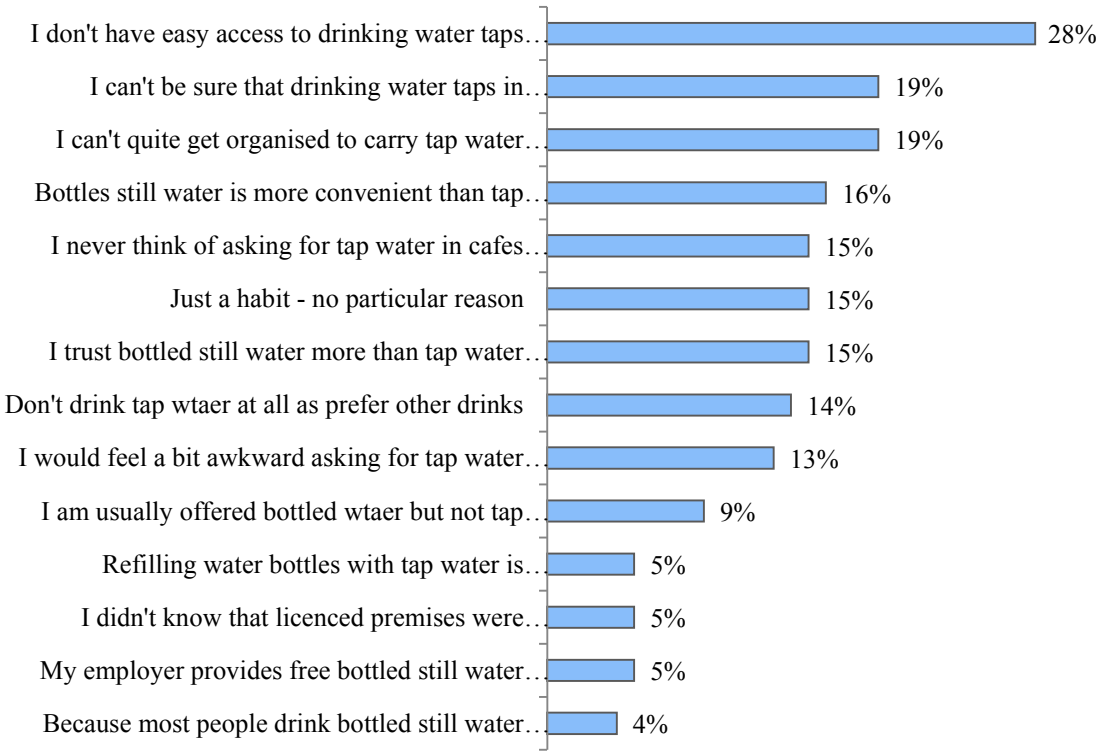


Figure 9: Reasons for drinking tap water at home but not in other places[2]

The rising popularity of tap water in restaurants is also confirmed by the bottled water industry, which reported that their on-trade sales have experienced a decline: *"While consumers are beginning to eat out more frequently, there was a marked trend towards asking for tap water as a meal accompaniment."*[1]

Restaurants and bars that sell alcohol are obliged to serve tap water for free.[13] Yet one in five adults in England and Wales are not aware of this rule. Older age groups are least likely to know about it (26% of those aged 55+ and 20% of those aged 45-54 are unaware, whereas only 10% of those aged 18-24 and 14-15% of those aged 25-44 do not know about the rule).[2]

People who live outside of London are more likely to think it is false that licensed premises are obliged by law to provide free tap water.[2]
Readers of The Daily Mail (24%) and The Daily Telegraph (24%) are more likely than readers of The Guardian (16%) and The Independent (13%) to report that they think the statement is false.[3]

8. Hydration and mechanisms of water loss

Water is essential for the body to function. Among others, it provides a medium for most chemical reactions, it helps transport nutrients and it's particularly important for thermoregulation.

Hydration can imply the drinking of plain water, but it also covers water intake from other drinks and foods. There is a prevailing myth that water has a better hydrating effect than other beverages. Scientists warn that these claims are unsubstantiated: "It has long been put forth in medical, military, nutrition, and physiology texts that water from foods and beverages can meet fluid needs [just as plain water]".[14, 16, 18] The true benefit of water doesn't lie in its hydrating properties but rather in the fact that it is calorie-free and hence healthier than most other beverages.

Water is lost from the body predominantly via the kidneys and through sweating. These losses vary widely with intake, diet, activity level, temperature and clothing. Other losses occur insensibly via the skin and the lungs, and in the faeces.

While the combined influences of age, weight, gender and physical activity on hydration are complicated to estimate, elevated levels of water loss do occur above 25°C and therefore require increased intakes.[14] The usual assumption of

a 10% increase in evaporative water loss of 1°C per increase in body temperature of 1°C is not well documented, however.[15]

If the rate of water loss is higher than the rate of water intake, the body starts to suffer. At a fluid loss of 1% of body weight one feels thirsty; at 3% one's mouth gets dry.[16] In fact, the loss of body weight, denoting loss of body water, of about 1% is normally compensated within 24 hours.[27] Fluid losses of 2-3 litres of sweat over a few hours in the course of physical activity at high environmental temperatures are as a rule also compensated for within 24 hours by an increase in the fluid intake.[27]

9. Consequences of water imbalance

The body *can* tolerate dehydration. According to a 1964 study[17], the human body can cope with dehydration of up to 2-5% of body weight without functional disturbance. Yet more current science[18] warns that an increased rate of dehydration – with fluid losses of more than 1% – leads to reductions in exercise performance, in thermoregulation and in appetite. With fluid deficits of 2% and more severe performance decrements as well as poor concentration, headaches, irritability and sleepiness and increases in body temperature and respiratory rates are observed.[18,19]

With increasing dehydration cardiovascular function impairment is a common phenomenon – a rise in heart rate and difficulties in maintaining blood pressure. Mild dehydration (<2% loss of body weight) blunts baroreceptor control. The effects are more pronounced when heat stress is added to dehydration of 3-4%.[20]

Dehydration of more than 10% at high ambient temperatures brings serious risk of a life-threatening heat stroke through elevated body temperature and inadequate cardiac output leading to reduced perfusion of tissues and eventually to rhabdomyolysis and organ failure.[27]

Chronic dehydration can increase the risk of infection, especially of the urinary tract.[27]

A 2004 UK experiment[21] is worth noting at this point. Nine men and six women of mean age 30 undertook two trials: first, they were observed during normal states of body water content, i.e. absence of absolute or relative hydration or dehydration. Then the volunteers went through 37 hours of fluid restriction (FR). Blood and urine samples were collected and subjective feelings recorded at intervals throughout the experiment.

Nothing abnormal was observed in the euhydration trial, whereas the FR trial caused body mass reductions of 2-7%. Subjects had headaches, their ability to concentrate and their alertness were reduced. The authors noted that subjects had *"strong desire to drink and would have been unlikely to become dehydrated to such an extent accidentally"*.[19]

Symptoms of overconsumption range from nocturia, mild nausea, diarrhoea, lassitude and occasional light-headedness.[22] Extreme overconsumption can - under certain circumstances - lead to water intoxication with potentially life-threatening hyponatreamia (low sodium levels in blood). Hyponatreamia causes lung congestion, brain swelling, headache, fatigue, lethargy, confusion, vomiting, seizures and, eventually, coma. This has been observed in psychiatric patients, rarely in athletes and in ill-advised 'detoxing'regimens.[19]

10.The body's mechanisms to control water balance

The balance between output and intake of water is under homeostatic control. Water loss through urine is the dominant excretory pathway and is controlled by the kidneys, which also have the ability to conserve water when input is low. Feedback mechanisms which act primarily on the kidney are capable of sensing changes in tonicity of body fluids of 1 to 2%.[27]

The second main physiological mechanism is thirst, the brain's response to a rise in plasma osmolality.[19] Thirst is also a perceptual mechanism, in that it is triggered by taste, colour, flavour, and temperature of beverages.[27] Thirst occurs when body mass drops by 1-2%.[19] The British Nutrition Foundation points out that "there may be numerous physiological and behavioural variations in how people respond to thirst, which could modulate the effectiveness of thirst in preventing dehydration. For healthy people living in a temperate climate, fluid intakes may be driven by food and drink preferences or by cultural and social factors rather than primarily by thirst." They go on to conclude that "homeostatic systems in the body generally ensure that body water balance is maintained by regulating sensations of thirst and the quantity of urine excreted. In most healthy people, this results in a very precise control of water balance, and it is estimated that changes are maintained within 0.2% of body mass over 24 hours." [19,18]

It must be noted that some groups are more vulnerable to unintentional dehydration, however. Young children and adolescents in particular are at risk of impaired cognitive function (concentration, alertness and short-term memory) due to insufficient hydration.[23]

The elderly are identified as being at special risk of insufficient water intake due to loss of thirst sensation and appetite, and due to reduced capacity of their kidneys to concentrate urine.[7] Ill persons and chronic patients can also be at risk depending on their diagnosis and overall condition.[19]

Thirst is one indicator of dehydration. Urine colour is often considered another, but researchers suggest it does not show a precise correlation with hydration status and is, moreover, dependent on dietary factors and medications.[27]

11.Water intake guidelines

Many opinions as well as misinterpretations exist in the area of hydration guidelines. The '8x8' doctrine, i.e. drinking 8 glasses of 8 ounces (or 240ml) a day is one of them. This rule of thumb became widely spread in the 1990s together with the boom of still bottled water. The BBC tracked the 8x8 rule to WHO reports on water quality requirements. The WHO[24] was not primarily focusing on developing water intake guidelines; they were assessing guideline values for hazardous chemicals and generally assumed an average consumption of 2 l/d for a 60 kg person. Commercial industries then interpreted these reference values as guideline values and translated them into an '8x8' or 8 glasses a day marketing doctrine (8 ounces equals 1.9 litres).[25]

In reality, the optimal amount of fluid intake depends on environmental factors as well as on an individual's physiological characteristics such as body mass, metabolism and health conditions.

The only certainty is the need to maintain an input-output balance. Effects of breaking the balance are well studied and confirmed. But again, absolute values of intakes and outputs– such as given by the German Nutrition Society in Table 10 – come with high levels of uncertainty.

Water intake	ml/capita/day	Water output	ml/capita/day
Beverages	1440	Urine	1440
Food	875	Solid	160
Oxidation (metabolism)	335	Sweat	550
		Lungs	500
Total	2650	Total	2650

Table 10: An exemplary break-down of guideline daily water intakes and outputs [26]

More published evidence on fluid intake guidelines exhibits great disparities; examples are given in Table 11. The listed values refer to total fluid intake, however, not just to drinking. For the sake of suggesting Adequate Intakes (AI), the European Food Safety Authority (EFSA)[27] assumes 20% of fluids enter the body as food.

Source	Litres/capita/day
White et al. (1972)	1.8 - 3.0
US EPA (1976); National Academy of Sciences (1977)	2.0
Vinograd (1966); Roth (1968); WHO (1971)	2.5
NRC-NAS (1989)	2.0 - 4.5
Saunders & Warford (1976)	5.0

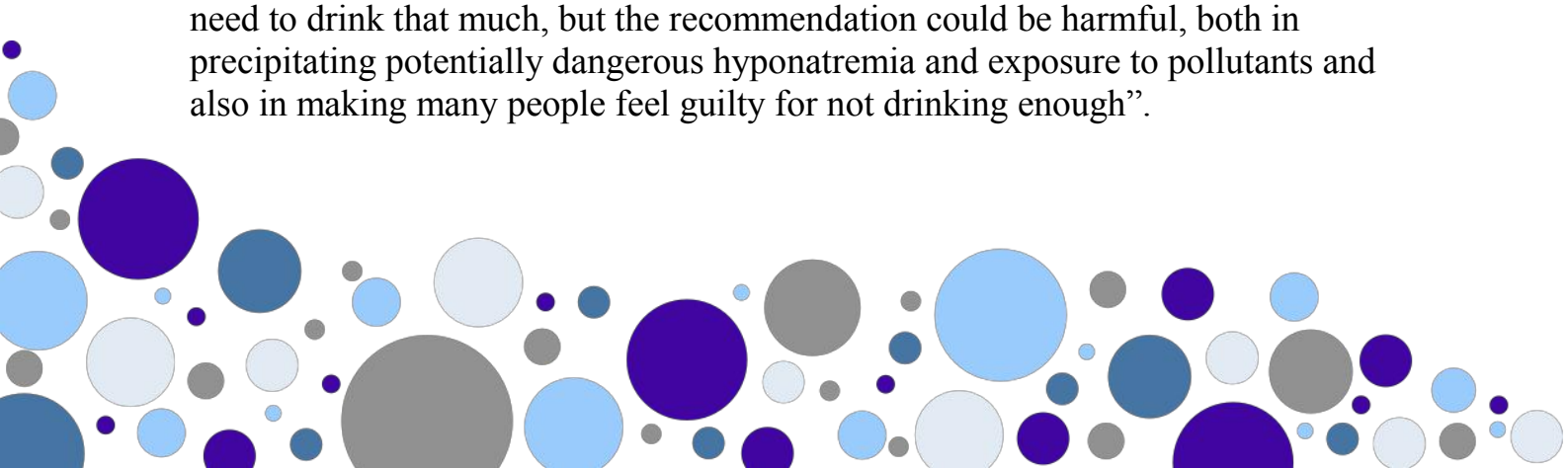
Table 11: Guideline daily fluid intakes according to various sources. Adopted from Gleick (1996)[28]

As said, total fluid intake must roughly equal total fluid output in order to prevent dehydration. The Food and Nutrition Board, cited in Grandjean[9], deem it impossible to go from this generic input-output balance rule to a quantitative recommendation fit for all. The British Nutrition Foundation come to the same conclusion in their hydration review: "It is not meaningful to give a specific recommendation regarding water requirements, as these vary widely depending on, for example, the age, gender, body mass, environmental conditions and the changing physical activity of the individual concerned."[19]

How did it then come about that many defined guidelines exist? The identified primary source[29] of information reporting "total water output in a healthy adult under temperate conditions" dates back to 1930: a five-day average output of 60kg male subject was 2675 ml, varying from 2227 ml to 3205 ml.

Nevertheless, reportedly the oldest evidence of an adequate water intake comes from a German book called Makribiotik[30], which mentions a noble man whose life and health has much improved after taking on a water diet of 7-8 glasses a day.

Heintz Valtin[31] warned that "not only is there no scientific evidence that we need to drink that much, but the recommendation could be harmful, both in precipitating potentially dangerous hyponatremia and exposure to pollutants and also in making many people feel guilty for not drinking enough".



Even though it is impossible to legitimately support water intake guidelines, Negoianu and Goldfarb[32] say the same about demolishing the claims of benefits; they conclude that there is currently lack of evidence in general and that scientist have neither proven water guideline values right nor wrong. Dr Simeon Margolis, professor of medicine and biological chemistry at the Johns Hopkins School of Medicine, then advises thirst as the best guide for the healthy population.[33]

12.European Adequate Intake (AI) levels

Data on water intake in European countries are unfortunately often not comparable because of differences in means of assessment and in the categorisation of beverages and liquid foods like milk (see **Table 12** for an overview). The same stands for US studies outlined in Table 11.

Numerous and detailed data on actual beverage consumption and food intake in adults are available in Europe. However, total water intake has not been calculated in all of them. Average total water intake ranges from 2,200 to 2,600 ml/day in men and from 1,900 to 2,400 ml/day in women.[27]

Germany, for example, recommended total water intakes for adults in a range of 2.2 to 3.7 l/day; recommended drinking volumes are around 1.5 l/day, while total available water intake should be 1 mL/kcal of energy consumed for adults and 1.5 ml/kcal for infants, 1.2 ml/kcal for toddlers and 1.1 ml/kcal for the elderly.[34]

Adequate intakes (AIs) should be based on both observed intakes – such as those listed in Table 1 and Table 2 – and on considerations of achievable or desirable urine osmolality. For the sake of defining its own water AIs, EFSA[7] settled with targeting a urine osmolality of about 500 mosm/l in order to provide a safe margin of a "free water reserve". [35]

To achieve a urine osmolality of 500 mosm/l adequate total water intakes would have to be 2.0 l/d for females and 2.5 l/d for males. These AIs only apply to conditions of moderate environmental temperatures and moderate physical activity levels. EFSA[27] reports detailed AIs also for specific age groups in children, for the elderly and for pregnant women.

The NHS recently revised its healthy eating tips and now advises people to drink *about* 1.6l to 2l per day on top of water from food.[36] EFSA[27] adds that no

single upper tolerable level for total water intake can be identified unless it takes into account individual and environmental circumstances.

The British Nutrition Foundation elaborates on that: "It is not meaningful to give a specific recommendation regarding water requirements, as these vary widely depending on, for example, the age, gender, body mass, environmental conditions and the changing physical activity of the individual concerned." [19]

	FR	DE	IT	SWE	NL	UK	BE
Total water							
men				2467	2622		
women		2259		2455	2402		
population	1984	1875			2222		
Total Beverages							
men	1236	1530	1027	1911		1988	1465
women	1130	1469	917	1895		1585	1342
adults			870				1401
children	838	520-690	744				
adolescents	920		757				807
elderly	1105		858				1393
				male/female			
non-alcoholic beverages	1023		846	1656 / 1766	1346 / 1463		1202
fruit juices	52		21	87/86	55/82	48/47	
lemonades	37		35	207/137	144/218	239/201	284
(mineral) water	557		660	384/680		239/314	658
coffee	199			489/431	730/553	318/243	366
tea	70			114/123	212/398	411/410	70
milk & milk drinks	108		130	376/312	357/332	225/200	
alcoholic beverages	156		112	255/129	355/100	500/139	190

Table 12: Mean water intake in ml/day in selected European countries. Adopted from an EFSA compilation[27]

13. Conclusions

A few conclusions can be drawn from this report:

- The role of water as nutrient and the benefits that this has in addressing national health challenge[37]s such as obesity or diabetes should be promoted both as a mechanism for remaining hydrated but also to offset the consumption of sugary drinks.

- In biological terms the source of water is not a factor – water comes from food and from drinks – including tap water. Water UK and its members as water utilities have a role to promote the benefits of tap water.

- There is a small part of the population that are concerned over the quality of tap water. Messages addressing these concerns and the actions being undertaken to protect public water supplies should be developed by water companies and stakeholder to address these concerns. Advice and tips are to be shared among those dissatisfied with tap water taste/odour.

- Access to tap water on the go is limited. More can be done to provide access and to promote its availability. Where tap water is available to the public then outlets need to be hygienic and well maintained. Consumption of tap water in cafes and restaurants can be encouraged among both customers and owners.

- Whilst the general population does not show signs of dehydration the elderly, ill, children, and other vulnerable groups may be at risk of dehydration. Qualitative as well as quantitative information should be targeted specifically at those at risk using a range of channel

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