

Bahía Study 2008: a hydration barometer of the Spanish population

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ABSTRACT

Background: Vital functions require a balance between the loss and ingestion of liquids. There are no studies about hydration on Spanish population. **Material and methods:** 6,508 questionnaires were applied to a randomly selected Spanish population, together with a 24-hour recall in order to measure liquid consumption and variables related to it. **Results:** The average consumption of liquids was $2,089.5 \pm 771.4$ and 6.05 drinking times/day. 3,423 persons (52.6% of the studied people, CI 95% 51.3%-53.8%) were well-hydrated when considering their individual intake. The frequency and volume of drinking decreased with age. 61% (CI 95% 58.64%-64.01%) of the population older than 65 years were badly hydrated. The greatest bottled water consumption corresponded to the youngest population (18-29 years). The greater the physical activity, the greater the beverages consumption ($1,987.6 \pm 705.5$ ml vs $2,345.8 \pm 928.1$ ml, low vs. intense physical activity, respectively). With regard to the intake frequency and volume, mineral and tap water were the most consumed. Those who drank mineral water exceeded the 2 l-recommendation in order to maintain a good hydration status. 59.8% (CI 95% 57.83%-61.76%) of those who preferred mineral water drank more than 2 l/day and drank more times/day and in greater amounts. There was a greater frequency and amount of beverage consumption when people lived in the same house, and particularly more in houses where children were living ($2,197.4 \pm 767.8$ ml vs $2,055.7 \pm 769.86$ ml and 6.4 ± 2.2 times vs 5.9 ± 1.9 times, in homes with or without children, respectively). Bottled water was preferred at home (79.07%) and at work (15.61%). **Conclusions:** Only half of the Spanish population is well hydrated. Sixty-one percent of people over the age of 65 years were poorly hydrated, consequence it is imperative to promote its consumption. **Key words:** Hydration. Water consumption. Mineral water. Age. Physical activity. Spanish population.

Estudio Bahía 2008: barómetro de la hidratación de la población española

RESUMEN

Antecedentes: Las funciones vitales requieren un equilibrio entre pérdidas de líquidos e ingestión de éstos. No existen datos sobre hidratación en la población española. La Sociedad Española de Nefrología puso en marcha el presente estudio. **Material y métodos:** Se aplicaron 6.508 encuestas en población española seleccionada aleatoriamente, así como un recordatorio de 24 horas para medir el consumo de líquidos y las variables asociadas con éste. **Resultados:** Se observó un consumo medio de líquidos de $2.089,5 \pm 771,4$ ml en 6,05 tomas/día; 3.423 personas (el 52,6% de la muestra; intervalo de confianza [IC] 95%, 51,3-53,8%) estuvieron bien hidratadas al considerar su consumo individual. La frecuencia y la cantidad de ingestión de líquidos disminuyeron según aumentaba la edad. Un 61% (IC 95%, 58,6-64,0%) de los mayores de 65 años no estuvieron bien hidratados. El mayor consumo de agua embotellada lo realizaban los jóvenes (de 19 a 29 años). A mayor intensidad de actividad física, mayor cantidad de líquidos ingeridos ($1.987,6 \pm 705,5$ frente a $2.345,8 \pm 928,1$ ml, actividad física baja e intensa, respectivamente). En cuanto a frecuencia de consumo y volumen ingerido, el agua mineral y el agua del grifo fueron mucho más consumidas que otras bebidas. Quienes beben agua mineral superan los 2 litros recomendados para mantener una buena hidratación. Un 59,8% (IC 95%, 57,8-61,7%) de quienes preferían consumir agua mineral natural ingirieron más de 2 l de líquido al día y bebieron un mayor número de veces/día y en mayor cantidad. Se observó una mayor frecuencia e ingestión de líquidos en personas que vivían en el mismo hogar, particularmente cuando había niños ($2.197,4 \pm 767,8$ frente a $2.055,7 \pm 769,86$ ml y $6,4 \pm 2,2$ frente a $5,9 \pm 1,9$ veces, en hogares con y sin niños, respectivamente). El agua embotellada se consumió preferentemente en el domicilio (79,07%) y en el trabajo (15,61%). **Conclusiones:** Sólo la mitad de los españoles adultos se encuentra bien hidratada. El 61% de los mayores de 65 años están deficientemente hidratados, por lo que es necesario promocionar una correcta hidratación en esta población especialmente. **Palabras clave:** Hidratación. Consumo de agua. Agua mineral. Edad. Actividad física. Población española.

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INTRODUCTION

The distribution and composition of body fluids has profound effects on cell functions. The optimal functioning

of any living organism requires internal homeostasis and even small changes in pH, concentrations of electrolytes and fluid balance can have adverse effects.¹ Total body water content accounts for approximately 50-60% of an adult's body weight (in men and women respectively) and it is distributed within an intracellular and another extracellular compartment. Water moves across osmotic gradients to maintain a balance between these spaces.

The average adult consumes from 2,000 to 2,500ml of liquid a day. Approximately 1,500ml of this amount are consumed in the form of liquids. The rest is obtained from solid foods or produced by oxidative metabolism.² About 300ml of water are produced as a result of the oxidation of carbohydrates, fats and proteins.

In order to maintain our fluid balance, *unperceived* losses and losses in urine, faeces and perspiration must be offset by an adequate intake of liquids. Our daily liquid requirements are determined by our individual metabolism, environmental conditions and level of activity³ and this not only varies from one person to another, but also in the same person from one day to the next. Our water requirements can be calculated from the data provided in table 1.⁴

Body water balance is the result of equilibrium between the consumption and loss of liquids.⁵ When intake and losses are equal, this balance is maintained. Thirst is a physiological need which is mediated by complex mechanisms that are triggered by an imbalance and its primary aim is to achieve the replacement of liquids.

Methods for evaluating hydration include dilution and impedance techniques, plasma indicators (osmolality, testosterone, adrenaline, noradrenaline, cortisol, atrial natriuretic peptide, aldosterone, blood urea nitrogen, sodium, potassium, plasma proteins and haematocrit values), changes in body weight and water loss (in urine and faeces, and during respiration and perspiration).³

Table 1. Calculation of Daily Liquid Requirements

Method 1

- Young adult sportsmen: 40ml/kg body weight
- Adults (18-55 years) 35ml/kg body weight
- Older adults 30ml/kg body weight

Method 2

- 1. 100ml/kg for the first 10kg of body weight
- 2. 50ml/kg for the second 10kg of body weight
- 3. Yes < 50 years, 20ml/kg for each additional kg of body weight
- Yes > 50 years, 15ml/kg for each additional kg of body weight

With the aim of evaluating the hydration levels of the Spanish population (type and quantity of beverages consumed and times of day when liquids are ingested), other factors associated with hydration (physical activity and the context in which liquids are consumed) and the consumption of bottled water amongst Spaniards, the Spanish Nephrology Association conducted a specially designed telephone survey.

MATERIAL AND METHODS

The study was based on an epidemiological, transversal population survey, which involved the completion of a computer-assisted telephone interview (CATI, Computer Assisted Telephone Interviewing), the only computer-assisted survey of its kind in mainland Spain, the Balearic Islands, the Canary Islands, Ceuta and Melilla.

A multi-stage, randomised sample, which was representative of the Spanish population (the reference population included all the subjects of both sexes over 18 years of age with their own telephone and resident in Spain), was taken and stratified according to the age (18-29 years; 30-45 years; 46-65 years; over 65 years), Autonomous Community and habitat of the survey participants (rural, semi-urban or urban, the latter with a population of less or more than 20,000). Altogether a total of 20,572 calls were made and from these 6,508 valid questionnaires were obtained, so the rate of response was 31.64%. The distribution according to age range and habitat was made in accordance with their distribution in the Spanish population (Spanish Institute of Statistics, INE 2004) (table 2).

When the size of the sample was calculated to estimate the percentage of people who are aware of the importance of healthy habits in looking after their bodies, maximum variability was assumed ($P = Q = 50\%$) and an accuracy level of 1.2% was set, so a sample size of 6,504 questionnaires was needed.

The consumption of liquids was assessed using a 24 reminder system and domestic measurements, which were later transformed to millilitres (ml). The types of ingested liquids which were analysed included water (tap water), mineral water (bottled water), juices, soft drinks and other liquids (coffee, tea, milk and alcoholic drinks). The time of day when these liquids were consumed was also investigated.

An intake of 2 litres of liquid was defined as adequate for hydration purposes. Physical activity, the number of people per home and the number of children under the age of 16 or people over the age of 65 per home were also analysed.

Table 2. Distribution of the sample according to sex, age and autonomous community

	Number	Percentage
Sex		
Male	3,188	48.99
Female	3,320	51.01
Age		
18-29 years	1,506	23.14
30-45 years	1,993	30.62
46-65 years	1,742	26.77
+65 years	1,267	19.47
Autonomous Community		
Catalonia	1,011	15.56
Andalusia	1,171	18.02
Community of Valencia	664	10.22
Madrid	861	13.25
Basque Country	333	5.12
Galicia	430	6.62
Castile-Leon	390	6.00
Aragon	192	2.95
Castilla-La Mancha	282	4.34
The Canary Islands	271	4.17
The Balearic Islands	133	2.05
Asturias	169	2.60
Murcia	190	2.92
Navarre	89	1.37
Extremadura	169	2.60
La Rioja	46	0.71
Cantabria	85	1.31
Ceuta	12	0.18
Total	6,498	100.00

RESULTS

Taking, as our yardstick, a consumption of 2L to be “good hydration”, the average consumption of liquids was seen to be 2,089.5 ± 771.4ml (average 2,000ml) distributed as 6.05 drinks throughout the day. However, only 3,423 people (52.6%, confidence interval [CI] 95%, 51.38-53.81%) were well hydrated when their individual consumption was evaluated in these terms.

With respect to age, a decreasing linear tendency was observed in the frequency and quantity of liquids consumed, as illustrated in table 3. A key finding is the fact that 61% (CI 95%, 58.64-64.01%) of the participants over the age of 65 years defined themselves as poorly hydrated.

In the same table we can see that, in any of the age groups, barely half of the interviewees drank the recommended amount of 2 litres.

Beverages were drunk at mealtimes (morning, midday, mid-afternoon and evening) and they were seldom consumed at other times. At morning, midday and evening, consumption was little more than half a litre of drink per meal. At mid-afternoon a slightly smaller amount was consumed and before breakfast 340ml (data not tabulated).

The consumption of bottled water was more common amongst the youngest subjects and, contrary to what happened in the case of bottled water, it was found that the older participants were, the more they consumed tap water (table 4).

Fifty-two percent of the people who were interviewed performed some kind of moderate physical activity and 56% practised sport regularly. We observed that the more intense the physical activity, the more liquids were consumed (1,987.6 ± 705.5 compared to 2,345.8 ± 928.1ml for people who performed low or high-intensity physical activity respectively). There was also a greater consumption of bottled water, juices and soft drinks (and a lower consumption of tap water) amongst people who performed intense physical activity. Consumption (frequency and amount) in accordance with physical activity is summarised in table 5.

With respect to the type of liquids which were consumed, it can be seen that most people consumed tap water, but, as far as the frequency of consumption and volume consumed is concerned, both mineral water and tap water were consumed much more widely than juices, soft drinks and other liquids (table 6).

Fifty-nine point eight percent (CI 95%, 57.83-61.76%) of the people who preferred to consume natural mineral water consumed over 2 litres of liquid a day and drank a greater number of times a day and in greater amounts than the rest of the population (data not tabulated).

There was a tendency to be more hydrated (greater frequency and greater volume of liquids consumed) when there were more people living in the home, particularly when there were children in the home (2,197.4 ± 767.8 compared to 2,055.7 ± 769.86ml in terms of volume and 6.4 ± 2.2 compared to 5.9 ± 1.9 times in homes with and without children respectively). There was also a greater consumption of bottled water, juices and soft drinks and a lower consumption of tap water when there were children in the home. There was a growing tendency to drink in the middle of the afternoon as the number of people who lived in the home increased; on the other hand, people who lived alone were more likely to have the habit of drinking before

Table 3. Water consumption distributed according to age (frequency and amount)

Age (years)	Frequency of	Times/day	Volume consumed (ml)	Volume consumed (ml)
	consumption > 2L (%; CI 95%)		Mean and SD	Average
18-29	58.23 (35.9-41.3)	5.93 ± 2.03	2,198.54 ± 825.71	2,080
30-45	58.15 (55.9-60.3)	6.28 ± 2.24	2,196.47 ± 794.73	2,100
45-65	51.49 (49.1-53.8)	6.11 ± 2.02	2,052.65 ± 751.50	2,000
>65	38.67 (35.9-41.3)	5.78 ± 1.75	1,842.29 ± 618.35	1,750

breakfast and at night.

The consumption of bottled water in the home was preferred by 79.07% of the people who took part in the survey, but also at work by 15.61% of the same participants; 91.24% of the participants preferred to drink tap water when they were at home and 7.4% when they were at work; 72.87% of those who consumed juices and soft drinks did so at home, 8.09% at work and 17.09% in bars and restaurants. As far as other beverages (coffee, tea or milk) are concerned, these were consumed in 86.13% of cases in the home, in 6.19% at work and in 7.25% in bars and restaurants.

Finally, it was found that people who drank mineral water exceeded the 2 litres recommended to maintain good hydration (table 7).

DISCUSSION

There is no single amount for liquid consumption which can ensure the proper hydration of half of the people who are apparently healthy under all environmental conditions.⁶ This is why the Food and Nutrition Board established the corresponding recommended intakes for various stages of life and, in the case of adults aged 19 to 50 years, it established a liquid consumption of 3.7 litres a day for men and 2.7 litres a day for women, although this consumption can increase considerably, depending on the level of physical activity, and in relative terms, depending on the temperature of the environment. When the recommendations for water

consumption were established, data from national US surveys was used. In this country foodstuffs contribute 20 to 30% of our total water intake, while beverages account for the remaining 70-80%. The reference values for the total consumption of water are based on the average water consumption recorded in NHANES III, rounded off to the nearest 0.1 litre value. Foodstuffs are believed to supply approximately 20% of our total water intake.

There are many other ways for empirically determining water requirements and one of these establishes the consumption of 1ml/kcal.⁷ For an epidemiological study like this one it is difficult to determine an individual water requirement for each person calculated in this way so a minimum volume of 2 litres was regarded as “good hydration”. The average liquid consumption of the Spanish population was seen to be sufficient and intake was consumed in 6 portions throughout the day (not only at mealtimes). It was also found that people who drank mineral water exceeded the 2 litres recommended to maintain good hydration. However, when actual individual consumption was analysed, it was concluded that only half of the population in the survey were well hydrated. Nevertheless, there are obvious limitations to the data on the consumption of water and its variability between individuals.⁸

Dehydration is the disorder most often associated with liquids and electrolytes in the most vulnerable elderly adults. Dehydration is not a benign condition. On the contrary, it is associated with an increasing risk of falls, urinary tract infections, dental disease, bronchopulmonary disorders,

Table 4. Consumption of different liquids depending on age (percentage of survey participants)

	18-29 years	30-45 years	46-65 years	>65 years
Bottled water	54.65	49.52	41.16	33.39
Tap water	55.05	59.01	62.57	67.96
Juices or soft drinks	57.90	51.08	42.25	29.99
Other drinks	85.92	91.32	92.82	95.11

Table 5. Water Consumption (Frequency and Amount) depending on Physical Activity

Physical Activity	Frequency of	Times/day	Volume consumed (ml)	Volume consumed (ml)
	consumption > 2L (%; CI 95%)		Mean and SD	Average
Low	47.09 (45-49.1)	5.75 ± 1.85	1,987.66 ± 705.57	1,910
Moderate	53.26 (51.5-54.9)	6.16 ± 2.10	2,093.91 ± 756.39	2,000
Intense	66.22 (61.9-68.4)	6.46 ± 2.228	2,354.82 ± 928.15	2,250

kidney stones, constipation and a decline in cognitive function in older adults.³ Patients with renal insufficiency (or even acute renal failure in certain subjects subjected to extreme dehydration conditions) are also at risk of dehydration. In this study, when liquid consumption was analysed with respect to age, it was seen that there was a decreasing linear tendency in the frequency and amount of liquid consumed and that only 39% of people over 65 years of age were well hydrated. This data coincides with data from the 2004 Health and Nutrition Survey of Canada.⁹

We also need to pay attention to the role of correct hydration in the dilution of the excreted metabolites of drugs in a population of people over the age of 65, who are often polymedicated (68% of pensioners consume one or more drugs),¹⁰ as this would facilitate a lower level of renal function stress.

With respect to the types of drinks which are consumed according to age, the data shows that the consumption of bottled water was more common amongst younger people, whilst tap water consumption was greater amongst people over 65 years of age. There is currently no data on the Spanish population which we can contrast with these findings.

It was observed that when physical activity increased, the consumption of liquids increased (especially bottled water, juices and soft drinks). It is known that one of the factors which most increase water requirements is physical activity. Athletes are a population group whose state of hydration is critical to their activity and, in fact, their performance can be compromised by a deficit of body liquids.¹¹

The data from this survey enables us to suggest that the more people who live in a home, the better individual hydration is and more so when there are children in the home. It is not yet known what the reason behind this phenomenon might be, but we think it might be due to greater attention being paid to diet and other related aspects within the family. In agreement with this tendency, we observed that preferences in the consumption of liquids were also more select in homes with children (bottled water, juices and soft drinks). This data partially coincides with data released by the Nutrition Committee of the Spanish Paediatric Society,

which indicated that the consumption of juices increased by 26.7% and the consumption of soft drinks by 41.5% from 1991 to 2001. However, the consumption of juices and soft drinks can lead to a lower consumption of foods and beverages of greater nutritional value, such as milk, so measures should be introduced to encourage the consumption of water and milk and to reduce the consumption of soft drinks.¹²

In Mexico the energy value of beverages with respect to total energy intake throughout the day is as much as 20.1% and this figure reaches 22.3% in the teenage and adult population.¹³ The replacement of sweetened drinks by plain water has been widely recommended and could reduce the calorie levels of the diet of people who are overweight.¹⁴ In addition, it has been discovered that, when food is consumed together with energy drinks (juices and soft drinks), food intake is increased and also its energy value but without it having any significant effect in terms of sating our appetite; this may be due to the fact that the sensory properties of energy drinks modifies food consumption.¹⁵ This recent evidence, which comes from a clinical study that investigated the consumption of food when accompanied by six different types of beverages, is in addition to the findings of 30 publications (15 transversal, 10 prospective and 10 experimental studies) in which it was demonstrated that the consumption of beverages containing sugar is definitely associated with weight gain and obesity, both in children and adults.¹⁶ In an adult population with non-alcoholic fatty liver (a manifestation of metabolic syndrome, which is a consequence of bad nutritional habits) an excessive consumption of soft drinks has also been described, this being an independent factor for the prediction of fatty liver in 82.5% of cases.¹⁷ Although more research needs to be done on this subject, there is sufficient evidence to propose public health strategies that limit the consumption of sugary drinks as part of a healthy life style. It needs to be remembered, nevertheless, that the data obtained from this study permits us to conclude that, in Spain at least, the majority of the population drink mostly water, albeit mineral or tap water, and they do so more often and in greater quantities than other drinks.

With regard to the consumption of other beverages, no other drink stands out and, if this had been the case, three facts

Table 6. Consumption of different liquids

Type of Drink	Frequency of	Times/day	Volume consumed (ml)	Volume consumed (ml)
	consumption > 2L (%; CI 95%)		Mean and SD	Average
Mineral water	45.33	3.44 ± 1.73	1,376.43 ± 721.93	1,250
Tap water	60.79	3.50 ± 1.81	1,422.73 ± 770.61	1,500
Juices or soft drinks	46.19	1.44 ± 0.74	457.93 ± 302.87	330
Other liquids	91.21	1.87 ± 0.97	437.26 ± 274.08	350

would need to be taken into account: *a*) that the consumption of coffee, tea and other drinks which contain caffeine does not increase the elimination of urine or have a negative effect on hydration indicators in individuals who are accustomed to consuming caffeine;¹⁸ *b*) that the consumption of milk is the consumption which is most associated with the intake of calcium, as occurs with the consumption of fruit juices; *c*) that the consumption of soft drinks correlates negatively with the consumption of calcium, but proper advice on diet and the addition of calcium to some foods and drinks has enabled this deficiency to be prevented.¹⁹ So we do not limit ourselves to recommending mineral water as a means of hydration, although the effect of beverages other than mineral water during meals on the consumption of food needs to be considered.¹⁵ In addition, it has been reported that people with a healthier eating pattern are more likely to exhibit an equally healthier pattern with regard to non-energy drinks.²⁰ In this study the diet of the participants was not analysed.

There are some aspects which represent limitations to this study. These include intrinsic aspects of sampling (the level of non-responders, the population with no telephone which could not be accessed) and the intrinsic limitations of the transversal nature of the survey, which do not allow cause-effect relationships to be clearly identified. Other limitations might be the absence of accurate ways of measuring other aspects that influence the ingestion of liquids and hydration

(climate, the amount of perspiration, the amount of food which is ingested and whether it is solid or semi-solid).

CONCLUSIONS

People hydrate themselves when they drink water or other beverages and when they eat foods which naturally contain water or to which water is added during their preparation. The real intake of liquids differs from one individual to another and is determined by thirst, habits, cultural factors, access, taste and other important factors, such as physical activity.

Only 3,423 people (52.6% of the study sample) were well hydrated; however, average consumption was 2,089.5 ± 771.4ml, which was consumed in 6.05 portions during the day. It was found that people who preferred to drink mineral water exceeded the 2 litres recommended to maintain good hydration.

The more intense physical activity was, the greater the amount of liquids consumed and, in particular, the amount of bottled water, juices and soft drinks.

With respect to age, a decreasing linear tendency in the frequency and amount of liquids consumed was observed. Sixty-one percent of people over the age of 65 years were poorly hydrated.

Table 7. Data on good hydration (frequency of consumption > 2L, frequency of consumption/day, volume consumed/day), depending on the type of beverage consumed

Preferential consumers of:	Frequency of	Times/day	Volume consumed (ml)	Volume consumed (ml)
	consumption > 2L (%; CI 95%)		Mean and SD	Average
Mineral water	59.8 (57.8-61.7)	6.2 ± 2.09	2.200.23 ± 789.59	2.100
Tap water	53.2 (51.5-54.9)	6 ± 2.07	2.104.78 ± 755.07	2.000
Juices and soft drinks	30.1 (25-35.3)	5.4 ± 1.62	1.786.08 ± 659.65	1.660
Other liquids	25.8 (21.9-29.8)	5.6 ± 1.83	1.616.17 ± 621.41	1.500

The consumption of bottled water was more common amongst the youngest participants and that of tap water amongst the population over 65 years of age. Most of the people who were interviewed drank tap water, but, as far as the frequency of consumption and volume consumed is concerned, both mineral water and tap water were consumed much more widely than juices, soft drinks and other liquids.

There was a greater frequency and volume of liquid intake in people who lived with others in the same home, particularly when they lived with children, and the consumption of bottled water, juices and soft drinks in these homes was also greater.

Bottled and tap water were consumed preferentially in the home, but also at work, while the consumption of juices and soft drinks occurred more in bars and restaurants than in the home and at work.

Only half of the Spanish population is well hydrated. As water is a vital liquid, which enables a multitude of functions to be performed in the body and, in the case of the Spanish population, it constitutes part of the consumption profile, it is imperative to promote its consumption and, in particular, to foster the drinking of water which is bacteriologically safe and compositionally stable.

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