Water intake and hydration indices in healthy European adults

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Hydration is a public health issue

What do we do to assure that people are well hydrated?

EFSA's recommendations on water intake

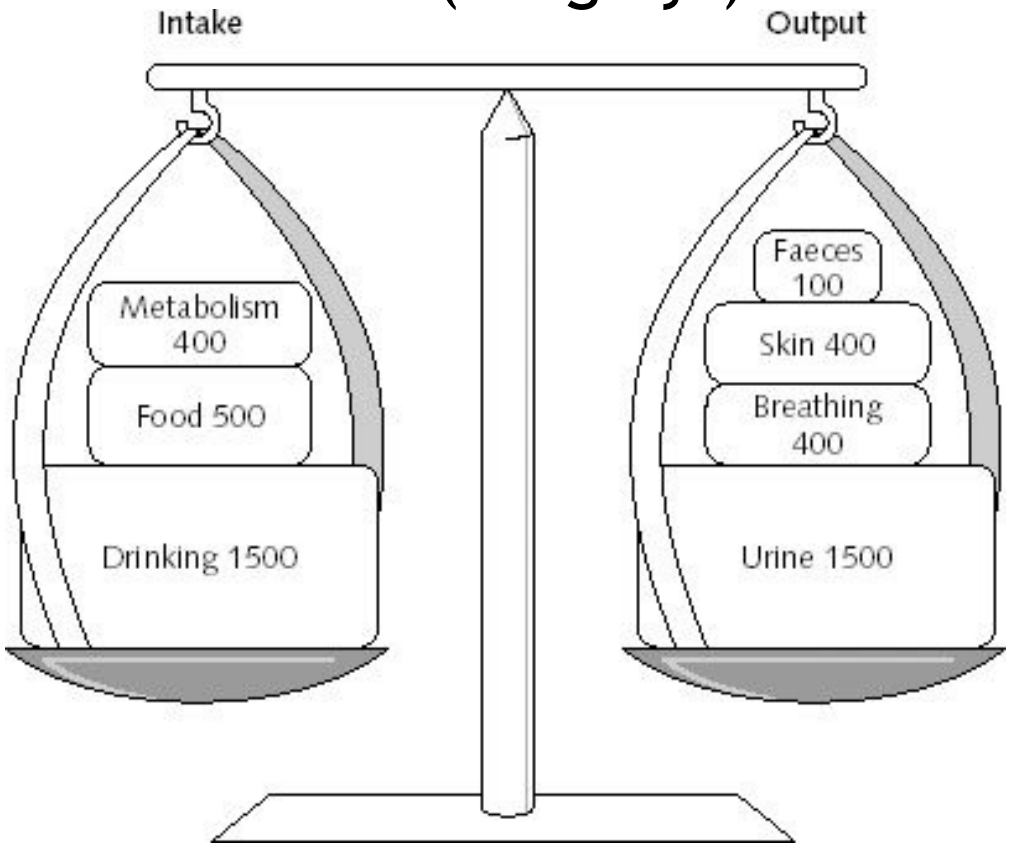
Age range	Daily adequate water intake
Adolescents (Males / Females)	
9-13 years	**2.1** L/day / **1.9** L/day
14-18 years	**2.5** L/day / **2.0** L/day
Adults (Males / Females)**	
19-70 years	**2.5** L/day/ **2.0** L/day

Water intake from solid foods and beverage

Approx. 80%

Approx. 20%

The concept of water balance quantitatively, in mL (roughly!)



✓Water intake is insufficient for predicting or evaluating water balance

✓Water balance is insufficient for predicting or evaluating hydration status

Lack of information on hydration status in European populations may be a barrier for justifying, developing and implementing hydration strategies for the general public

What do we need?

- Research tools for evaluating water intake and water balance and measure hydration status
- Reliable hydration status indicators
- Accepted cutoffs for hydration indices to characterize euhydration.

Article

Water Intake and Hydration Indices in Healthy European Adults: The European Hydration Research Study (EHRS)

Olga Malisova [1], Adelais Athanasatou [1], Alex Pepa [1], Marlien Husemann [2], Kirsten Domnik [2], Hans Braun [2], Ricardo Mora-Rodriguez [3], Juan F. Ortega [3], Valentin E. Fernandez-Elias [3] and Maria Kapsokefalou [1,*]

Nutrients 2016, *8*, 204; doi:10.3390/nu8040204

Research Partners

Funding

✓The European Hydration Institute

✓Maria Kapsokefalou et al, Agricultural University of Athens, Greece
✓Hans Braun et al. , German Sport University, Cologne, Germany
✓Ricardo Mora et al., University of Castilla-La Mancha, Toledo, Spain

577 volunteers, 20-60 y

invitations announced at work sites, fb, boards, etc

exclusion criteria applied

200 per country (approx)

equal numbers in each decade of life, gender, season

Study Protocol

Day 1

- Get instructions, study material
- Provide first morning urine void and blood sample
- Measure weight and height

Days 1-7

- Collect and store all urination
- Record all foods and drinks consumed

Day 8

- Turn in all samples collected
- Provide first morning urine void and blood sample
- Measure weight

Water intake from beverages and foods

Water intake from foods and beverages (7D diaries)

	Winter		Summer	
Water intake	Men	Women	Men	Women
Total (L/day)	**2.8±1.1**	**2.5±0.8**	**3.1±1.1**	**2.6±0.9**
Beverages (L/day)	**2.1±1.1**	**1.9±0.7**	**2.4±0.9**	**2.0±0.8**
Foods (L/day)	0.7±0.4	0.6±0.3	0.7±0.3	0.6± 0.3

Water intake from beverages

- ✓higher in men than in women
- ✓higher in summer than in winter
- ✓Approximately 80% from beverages

Hydration indices in blood and urine

Table 1. 24 h urine hydration indices of participants in winter and summer.

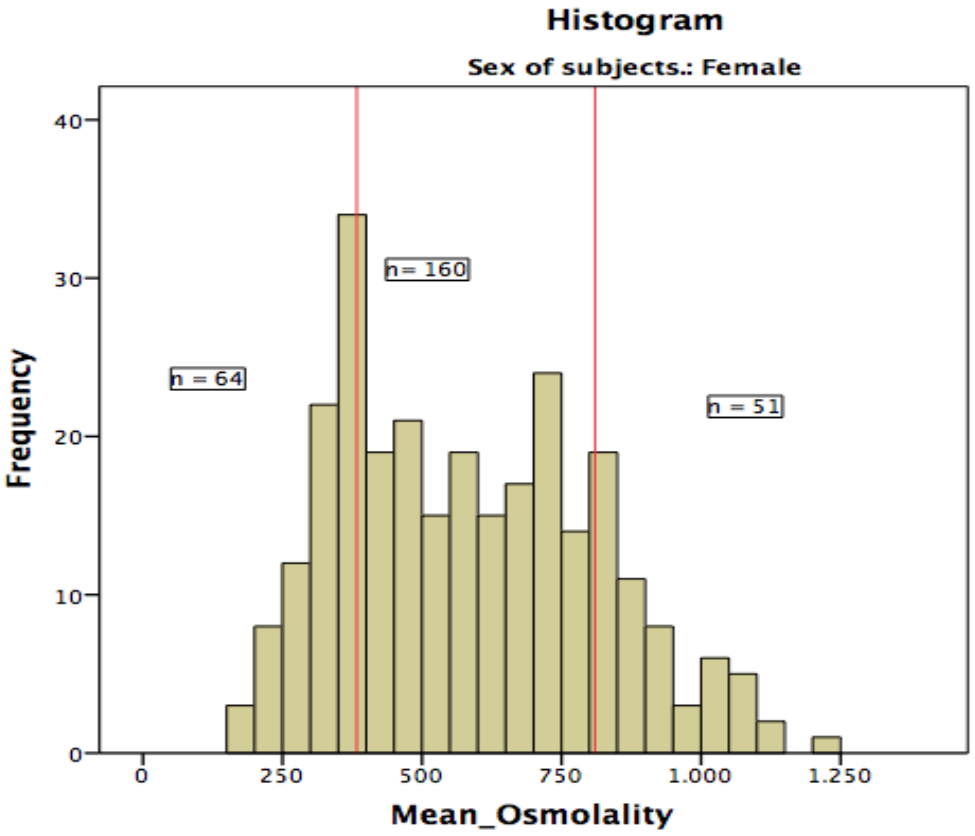
		Urine Osmolality (mOsmol/kg H_2O)	Urine Volume (L)	USG	Color
Winter	Male	652 ± 211	1.66 ± 0.62	1.018 ± 0.005	4.4 ± 1.4
	Female	571 ± 197	1.70 ± 0.72	1.016 ± 0.005	4.1 ± 1.3
	Total	615 ± 209	1.68 ± 0.66	1.017 ± 0.005	4.2 ± 1.4
Summer	Male	698 ± 192	1.61 ± 0.70	1.018 ± 0.005	4.6 ± 1.2
	Female	596 ± 251	1.63 ± 0.77	1.015 ± 0.006	3.9 ± 1.6
	Total	645 ± 230	1.62 ± 0.73	1.017 ± 0.006	4.2 ± 1.5
	P1	0.001	0.586	0.003	0.069
	P2	<0.001	0.789	<0.001	<0.001
	P3	0.111	0.370	0.679	0.983
Winter & Summer	Total Male	675 ± 203	1.63 ± 0.66	1.018 ± 0.005	4.5 ± 1.3
	Total Female	585 ± 229	1.66 ± 0.74	1.015 ± 0.006	4.0 ± 1.5
	Total Sample	631 ± 221	1.65 ± 0.70	1.017 ± 0.005	4.2 ± 1.4
	P4	<0.001	0.619	<0.001	<0.001
Country	German	492 ± 170 $^{*,\#}$	2.13 ± 0.76 $^{*,\#}$	1.014 ± 0.005 $^{*,\#}$	4.4 ± 1.3 $^{\#}$
	Spain	753 ± 180^{+}	1.40 ± 0.49	1.019 ± 0.004 $^{+}$	4.4 ± 1.5 $^{+}$
	Greece	658 ± 224	1.36 ± 0.50	1.017 ± 0.006	4.0 ±1.5
	P5	<0.001	<0.001	<0.001	0.008

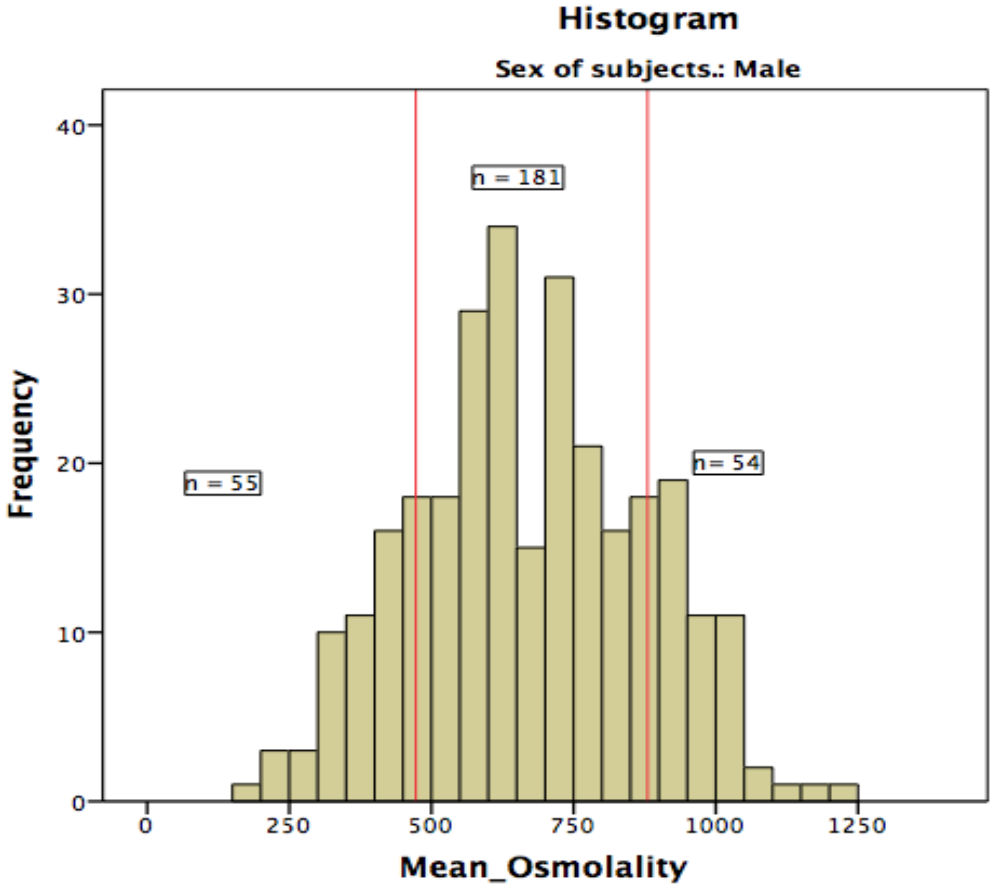
Distribution of Urine Osmolality (24h)

Women
(583±228 mOsm/kg)

Men
(671±202 mOsm/kg)

p<0.001

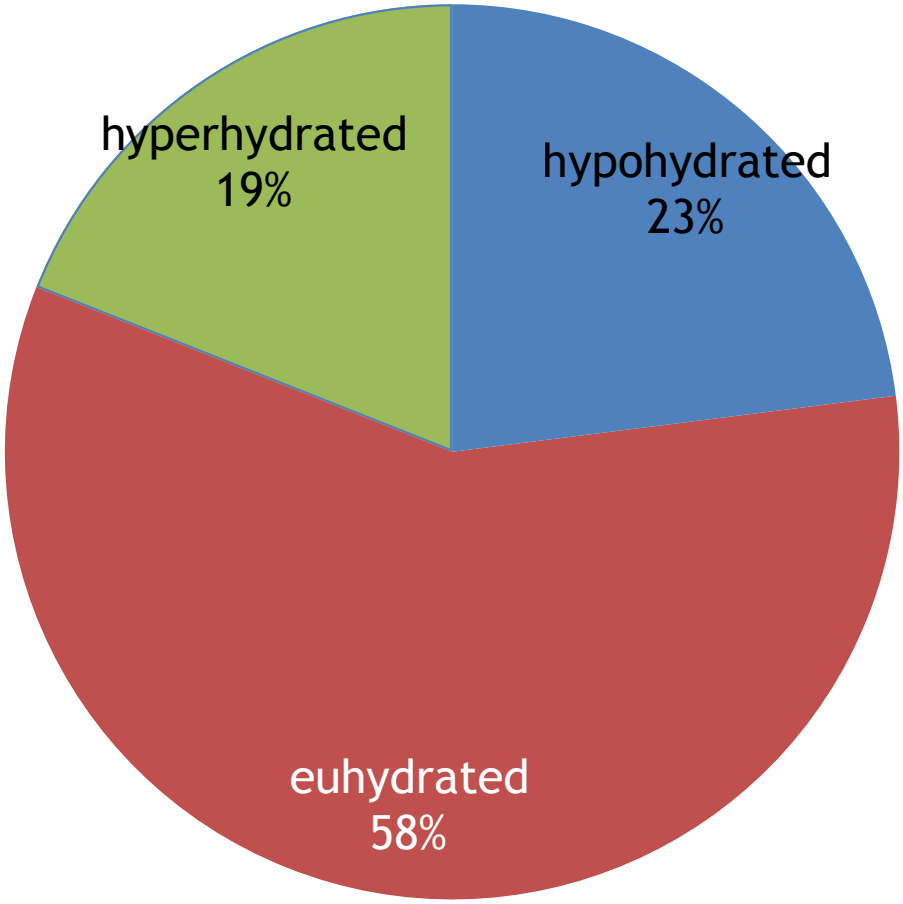




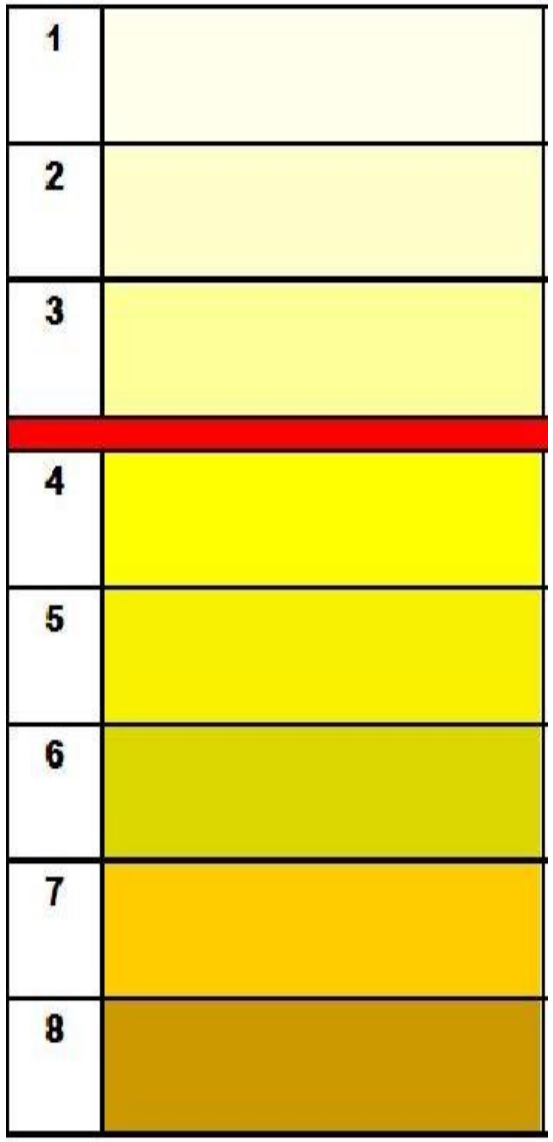
Only 60% of volunteers were euhydrated

Euhydration when Urine Osmolality in 24 h urine samples is 383-810 mOsm/kg in women and 475-880 mOsm/kg in men

(Armstrong 2010, 2012)



Urine color evaluated in 24 h urine samples



Men	Women	p
4.5+1.3	3.9+1.5	<0.001

Hydration in men and in women

Urine osmolality*
Specific gravity*
Color*
Serum osmolality

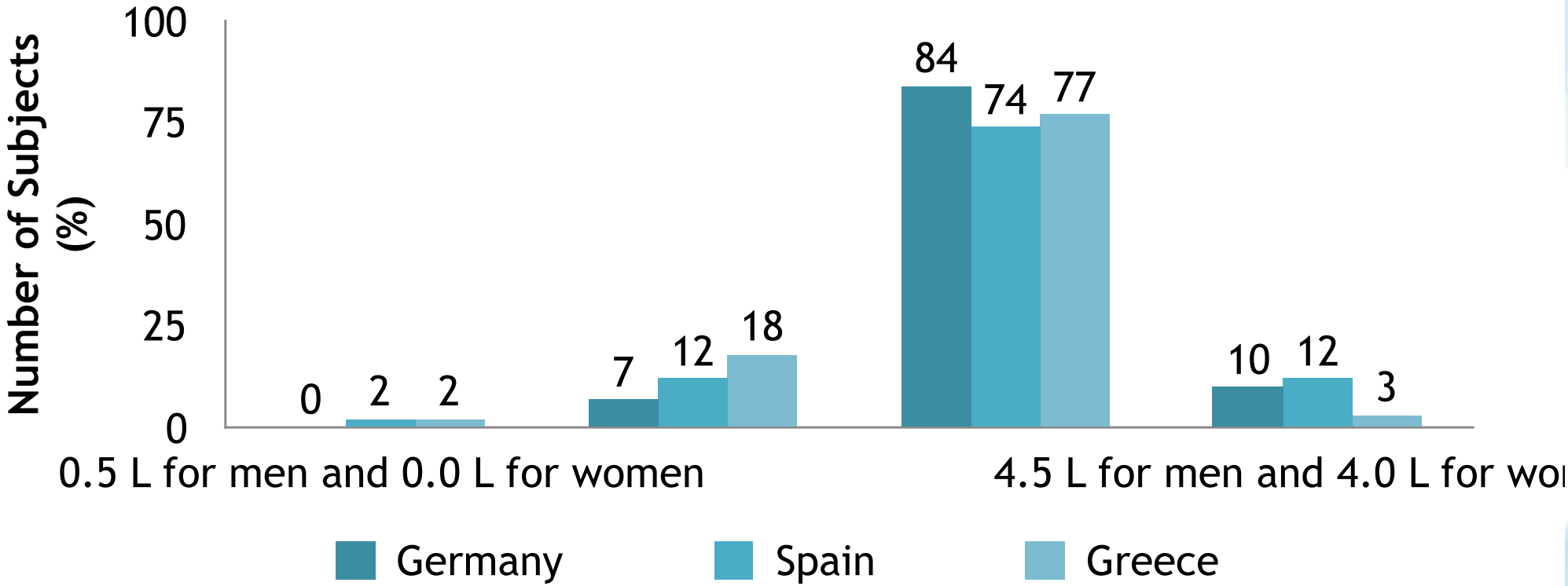
were higher in men than in women.

*measured in 24h urine samples

Perceptions and Knowledge

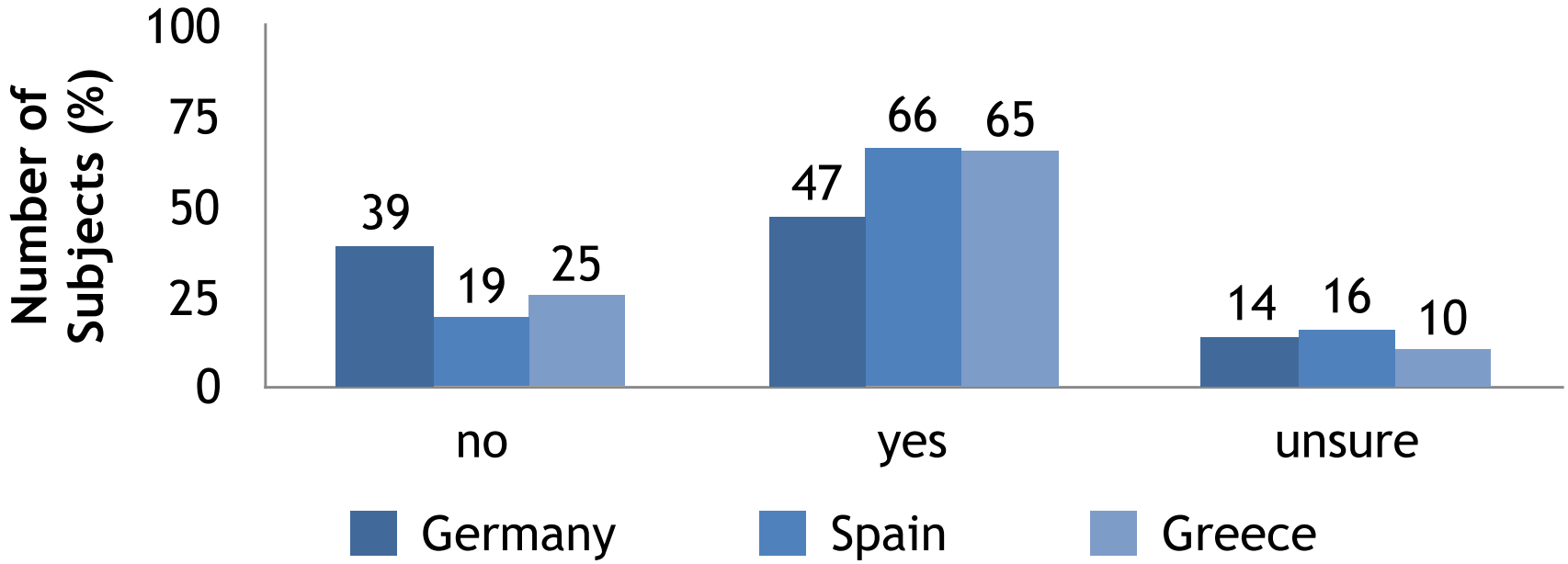
Question: How much water, from foods and drinks, does an adult typically require each day? (n=457)

Wrong Answer: approx. 20 % of subjects



Implication: A thought of a higher required daily water intake is followed by a higher mean total water intake ($p<0.05$).

Question: Is thirst a good indicator of dehydration? (n=461
Answer: Approximately 50% said „yes“



Implication: These volunteers had
- lower Urine Volume (1.7±0.7L vs. 1.9±0.8L; p=0.002)
- higher Urine Osmolality (620±221 mosmol/kg vs. 553±210 mosmol/kg; p=0.004)

Key Findings from The European Hydration Research Study

Water Intake

- Average intake close to the AI set by EFSA
- Water comes from a variety of foods and beverages

Hydration status

- Approximately 60% of our volunteers was euhydrated

Knowledge and Perceptions

There is knowledge gap that affects hydration habits and status

Water intake from beverages and foods

Article

Water Intake in a Sample of Greek Adults Evaluated with the Water Balance Questionnaire (WBQ) and a Seven-Day Diary

Adelais Athanasatou, Olga Malisova, Aikaterini Kandyliari and Maria Kapsokefalou *

Nutrients **2016**, *8*, 559; doi:10.3390/nu8090559

The Water Balance Questionnaire (WBQ)

(Malisova et al., 2011)

We designed a questionnaire that estimates

- Water intake from solid and fluid food and drinking water (FFQ)
- Water loss from urine, feces and sweat (Likert scales, IPAQ and conversion factors)

We validated the WBQ using 4 hydration indices (n=40) and tested for repeatability (n=175)

Evaluation of seasonality on total water intake, water loss and water balance in the general population in Greece

(Malisova et al., 2013)

Summer, (n=480)

Water Intake	**3875** ± 1373
Water from drinking water and beverages	3142 ± 1136
Water from beverages	860 (556, 1240)
Water from drinking water	2225 ± 997
Water from foods	560 (453, 845)

Winter, (n=412)

Water Intake	**2892** ± 987
Water from drinking water and beverages	2154 ± 745
Water from beverages	716 (471, 1036)
Water from drinking water	1352 ± 556
Water from foods	656 (459, 894)

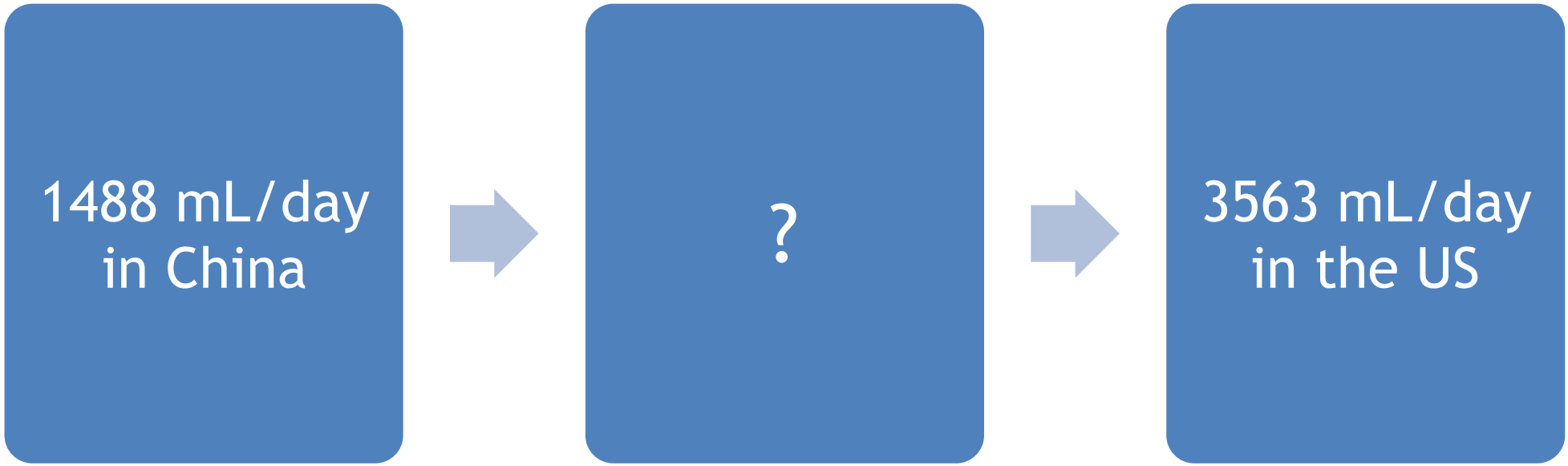
Contribution of foods and beverages to total water intake using the WBQ (n=1107)

		Contribution to Water Intake (g/Day) WATER			
		Total	Male	Female	p^3
	Count	1107	532	575	
All food and drink	Mean (SE)	3254 (43)	3404 (66)	3116 (55)	0.001
Food only	Mean (SE)	706 (12)	683 (19)	727 (16)	0.07
Beverages only	Mean (SE)	2551 (39)	2725 (61)	2390 (50)	<0.001
Hot beverages	Mean (SE)	330 (9)	307 (13)	351 (13)	0.02
Milk	Mean (SE)	160 (6)	158 (9)	162 (7)	0.69
Fruit and Vegetable Juices	Mean (SE)	119 (7)	126 (11)	112 (9)	0.34
Caloric soft drink	Mean (SE)	64 (4)	80 (7)	48 (4)	<0.001
Diet soft drink	Mean (SE)	52 (4)	47 (5)	57 (7)	0.25
Alcohol	Mean (SE)	146 (13)	215 (26)	82 (8)	<0.001
Water	Mean (SE)	1671 (30)	1779 (43)	1571 (40)	<0.001
Other non-alcoholic beverages	Mean (SE)	9 (1)	14 (2)	5 (1)	<0.001

Contribution of foods and beverages to total water intake using 7 day diaries (n=178)

	Contribution to Water Intake (g/Day)			Co
	Total	Male	Female	p^1
Count	178	91	87	
All food and drink	Mean (SE) 2349 (59)	2517 (91)	2174 (71)	0.003
Food only	Mean (SE) 504 (17)	501 (21)	508 (27)	0.848
Beverages only	Mean (SE) 1826 (57)	1990 (90)	1653 (63)	0.003
Hot beverages	Mean (SE) 286 (17)	282 (22)	291 (26)	0.779
Milk	Mean (SE) 119 (8)	116 (12)	122 (12)	0.721
Fruit and vegetable juice	Mean (SE) 63 (6)	57 (8)	69 (8)	0.272
Caloric soft drink	Mean (SE) 27 (4)	30 (5)	24 (6)	0.486
Diet soft drink	Mean (SE) 23 (6)	33 (10)	12 (5)	0.075
Alcoholic drinks	Mean (SE) 81 (9)	84 (12)	77 (12)	0.696
Water	Mean (SE) 1170 (54)	1310 (86)	1023 (61)	0.007
Other beverages	Mean (SE) 18 (3)	23 (6)	12 (2)	0.096

Data on total water intake vary



(Athanasatou et al, 2016)

Comments on different methodologies for recording water intake

- FFQ
- One or two 24 h recall
- 3 day diaries
- 7 day diaries

It seems that tools or studies designed to record food intake underreport water intake.

(Athanasatou et al, 2016)

Table 7. Water and energy intake of subjects the first three days and the seven days of the experiment using day diaries (n = 178).

Variable	3 Days	7 Days	p
Total water intake (mL/day)	2412 (63)	2351 (59)	0.005
Water intake from beverages (mL/day)	1869 (60)	1826 (57)	0.027
Water intake from foods (mL/day)	535 (19)	505 (17)	0.009
Total energy intake (kcal/day)	1818 (38)	1775 (35)	0.017
Energy intake from beverages (kcal/day)	201 (9)	207 (9)	NS
Energy intake from foods (kcal/day)	1573 (36)	1512 (31)	0.011
Hot beverages (mL/day)	302 (19)	290 (17)	NS
Milk (mL/day)	138 (11)	143 (10)	NS
Fruit and vegetable juice (mL/day)	79 (8)	72 (8)	NS
Caloric soft drinks (mL/day)	29 (6)	31 (4)	MS
Diet soft drinks (mL/day)	28 (8)	26 (7)	NS
Alcoholic drinks (mL/day)	85 (10)	100 (11)	0.036
Water (mL/day)	1233 (55)	1176 (54)	0.004
Other beverages (mL/day)	16 (3)	20 (4)	0.159
Variety score	4	5	0.0001

p-values derived through Student's t-test between three and seven days of the experiment.

5. Conclusions

In conclusion, water intake using the WBQ recorded a higher water intake than the seven-day diaries in a sample of Greek adults, yet both methodologies found that the beverages that were consumed in larger volumes were water, hot beverages, and milk. This work implies caution when interpreting data obtained from different approaches and highlights the need for concerted efforts towards developing a robust, validated methodology for the evaluation of water intake in the general population.

Hydration remains
a public health issue and a challenging research question

Time for action!

Urine collection