



## Which time of the day do we have the lowest hydration status?

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Mild dehydration may occur during the day because of poor drinking and eating habits or poor accessibility to a variety of fluids or foods<sup>(1)</sup>. Data on simultaneous water intake and hydration status from healthy free-living subjects are limited. The evaluation of hydration indices measured in every individual urine sample collected throughout a day may reveal potential intervals of mild dehydration and subsequently encourage focused advice on hydration schemes<sup>(2)</sup>. It is therefore of unequivocal importance to measure a) urine hydration indices in short time interval (6 h) urine samples, collected over a 24 h period and b) water intake from all sources per time interval (6 h). Linking information on hydration status, water intake and variety of beverages intake in short time intervals during the day will elucidate factors that may lead to mild dehydration.

A total of 164 healthy subjects (aged  $38 \pm 12$  yrs; BMI  $24.9 \pm 4.7$  kg/m<sup>2</sup>) were enrolled in the study, which was conducted in Athens, Greece (6–8/2013, 1–2/2014, 6–7/2014). Subjects recorded their food and drink intakes and recorded and collected all urine specimens for three consecutive days. Water intake and urine hydration indices were assessed in 6 h intervals over the day from wake up time. Hydration indices (volume, osmolality, urine specific gravity (USG) and colour) were measured in all 6 h intervals, first morning and 24 h urine samples. Beverages consumption consisted of the following categories: 1) hot beverages; 2) milk; 3) fruit and vegetable juices; 4) caloric soft drinks; 5) diet soft drinks; 6) alcoholic drinks; 7) water and 8) other beverages.

Values of hydration indices of morning, afternoon, evening, overnight, first morning and 24 h urine samples.

Hydration Indices	Morning		Afternoon		Evening		Overnight		First morning urine		24 h	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Volume (mL)	557	231	378	205	290	158	177	149	339	123	1331	144
Osmolality (mOsm/kg)	620	240	627	258	580	254	271	157	691	224	665	223
USG	1.017	0.006	1.017	0.006	1.019	0.007	1.016	0.007	1.018	0.008	1.017	0.006
Colour	3	2	3	1	3	2	1	2	3	1	4	2

The effect of time was significant for volume ( $F = 117.191$ ;  $p < 0.001$ ), osmolality ( $F = 65.228$ ;  $p < 0.001$ ), USG ( $F = 5.096$ ;  $p = 0.003$ ) and colour ( $F = 65.123$ ;  $p < 0.001$ ). Urine osmolality measured in the morning interval and first morning urine samples were far more likely to accurately reflect 24 h urine osmolality, compared to evening, afternoon and overnight intervals (Linear Regression Models). The urine volume of the morning interval samples reflects by 76 % the urine excretion over a day (24 h collection).

Mean daily total water intake was 2266 mL (SD 781). For water, the most popular beverage consumed, mean daily intake was 1168 mL (SD 666); following hot beverages 376 mL (SD 245), alcoholic drinks 198 mL (SD 237), caloric soft drinks 188 mL (SD 120), milk 160 mL (SD 123), fruit and vegetable juice 147 mL (SD 101). Total beverages intake was positively correlated with total daily water intake ( $r = 0.896$ ;  $p < 0.001$ ) and variety score ( $r = 0.238$ ;  $p < 0.001$ ). A peak on beverage intake was observed in the morning (hot beverages: 211 mL (SD 120); milk: 133 mL (SD 104)) and in the evening (alcoholic drinks: 154 mL (SD 138)). Water was preferred to other type of beverages throughout all short time intervals of day.

In conclusion, the produced urine volume was greater in the morning interval and decreased throughout the day. This fluctuation in urine volume follows the fluctuation of water intake by time. A morning interval sample, and not a spot urine sample (e.g. first morning urine sample) may be able to replace 24 h urine collection.

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