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**Effect of Urinary Urge on Using Urinary Frequency as an
Indicator of Hydration Status**

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ABSTRACT

Background: Void Frequency (VF) has recently been determined as a valid and reliable marker of 24-hr hydration status when void urgency is controlled (i.e., urinating at “first urge”). Limitations for real world applicability of this technique are apparent because individuals often void at varying urge levels throughout the day. **Purpose:** The purpose of this study was to determine if urgency affects the validity of void number as a marker of hydration status. We hypothesized that void urgency would not affect the validity of void number as a way to assess hydration status. **Methodology:** Participants included 18 females and 13 males (Age= 23 ± 9 yrs, BMI= 25.1 ± 4.1 kg/m²). Participants visited the lab 5 times; one familiarization visit and 4 experimental trials. The 4 randomized and counter-balanced experimental trials included: euhydrated ad libitum urge trial (EA), dehydrated ad libitum urge trial (DA), euhydrated first urge trial (E1) and dehydrated first urge trial (D1), where urgency was measured with a 0-4 scale (0= no sensation, 1 =first sensation, 2= first urge to void, 3 = strong urge and 4= uncomfortable urge). Ad libitum means individuals urinated “at free will”, while first urge meant individuals urinated at a “2” on the scale indicting the first urge to void. During the dehydrated trials, fluid intake was restricted to 500 mL per 24-hour period, while euhydrated trials encouraged fluid consumption. Regardless of the trial, participants were asked to collect their voids in medical grade urine containers and record the time of day, urgency, and thirst level while marking a line indicating the level of urine in the container. Lab analysis included measuring urine color, urine specific gravity (USG), and osmolality (OSM). **Results:** Urinary values for the E1 trial were: OSM= 451 ± 165 mosm/kg, USG= $1.012 \pm .004$, void number= 7 ± 3 . Urinary values for the EA trial were: OSM= 429 ± 187 mosm/kg, USG= $1.011 \pm .004$, void number= 7 ± 3 . Urinary values for the D1 trial were: OSM= 878 ± 133 mosm/kg, USG= $1.023 \pm .003$, void number= 4 ± 2 . Urinary values for the DA trial were: OSM= 895 ± 143 mosm/kg, USG= $1.024 \pm .003$, void number= 4 ± 1 . Urinary values between the first urge and ad libitum trials were not significantly different from each other independent of hydration status ($p > .05$). By using a two-way ANOVA test it was determined that hydration status affects void number (p -value $< .001$), however there was no effect of ad libitum urgency or first urge urgency on void number (p -value = $.50$). Additionally, there was no interaction between hydration status and urge to void instructions on void number (p -value= $.73$). **Conclusion:** These findings suggest that void urgency does not ultimately affect the validity of void number as a way to assess hydration status. Therefore, individuals can be instructed to urinate at any level of urgency and the number of times they void in 24 h is still a valid indicator of hydration status.

Introduction

The human body functions by maintaining homeostasis, which is the body's ability to maintain a constant and normal internal environment. A major component of the human body is water, nearly 55-75 % (1). Water functions as the medium of circulatory function, biochemical reactions, metabolism, substrate transport across cellular membranes, temperature regulation, and numerous other physiological processes (2). Because water plays essential roles within bodily functions and is subject to change via a number of ways (i.e. diet and fluid intake), there is a need for techniques to assess hydration status (2). Because hydration is an important factor to maintain homeostasis, it is important to develop ways that individuals can reliably check their own hydration status without having to use advanced laboratory techniques. Research has found that void frequency is a reliable index of 24- hour hydration, especially when void urgency is controlled (3).

Urgency to void involves complex neurobiology. It has been determined that two distinct brain areas control urgency and actual bladder fullness. The periaqueductal grey matter receives information about bladder fullness, while a network of other brain regions (i.e. premotor cortex) is involved in the perception of the urge to void (4). In order to measure void urgency, we used a scale of 0-4, where 0= no sensation, 1 =first sensation, 2= first urge to void, 3 = strong urge and 4= uncomfortable urge (4). In previous research studies, when investigating void frequency as an index of hydration status, urgency has always been controlled. Subjects were asked to void at an urgency of 2 or "first urge to void". Hydration is influenced by the quantity of fluids ingested compared to the amount of fluids excreted. It has been observed that in euhydrated adults, the quantity and frequency of their voids over 24-h are greater than that of dehydrated individuals

(6). Recent studies have shown that counting the number of voids over 24-hours is a valid (5) and reliable (3) method of assessing hydration status.

The purpose of this study was to determine if urgency affects the validity of void number as a marker of hydration status. We hypothesized that void urgency will not affect the validity of void number as a way to assess hydration status. This is important because in everyday life individuals are put in situations where they cannot feasibly void at the first urge (i.e., during meetings, during class, or on the road). Similarly, individuals might force themselves to go to the bathroom, before they even have an urge (i.e. before a movie or before a long car ride). Therefore, it is necessary to know if someone who is going to the bathroom whenever they want is still able to use void number as an accurate assessment of hydration in daily living.

Methodology

In order to investigate how urgency relates to the validity of void number as a marker of hydration status, we asked the subjects to record their urgency on medical grade urine containers. Participants in this study reported to the Human Performance Laboratory for a total of five visits:

- A familiarization visit
- Euhydrated trial, 2 trials
- Dehydrated trial, 2 trials

Participants of this study were 18 healthy females and 13 healthy males (Age= 23 ± 9 yrs, BMI= 25.1 ± 4.1 kg/m²). Participants were free from chronic illness and did not take fluid-altering medications. This study was approved by the University of Arkansas's Institutional Review Board.

During the familiarization visit, we explained what the participant should expect to experience during the subsequent trials of the study. An informed consent was explained and signed before baseline measures were gathered. We collected their medical history, caffeine sensitive, and a 7-day caffeine recall form and an activity questionnaire. For female participants, a menstrual history questionnaire was administered. Furthermore, we recorded their age and body mass. Height was obtained by a stadiometer. Forms used during the trial days were explained (i.e. diet and food logs along with the thirst and urge scales). The subsequent trials were randomized and counter balanced.

Participants were asked to refrain from alcohol consumption, excessive caffeine consumption (>6 cups of a coffee), and physical activity during the experimental trials. During the collection periods of trials, subjects kept a food and fluid log and was provided with a medical grade urine container to collect urine over a 24-hour time period. The first void of the day was in the toilet, subsequent voids until the first urination of the next day, was collected in the large medical grade container. The next morning void was collected in a separate container. Each collected void was marked on the side of the container to indicate the quantity with a line. In addition to the line, subjects indicated the urge to void, and the time of day of the void. The restrictions and measurements were followed for all experimental trials.

During the euhydrated trial, the participant was encouraged to drink fluid throughout the day. Since there are two days of each trial, a food and fluid log was kept and repeated for additional trails in order to replicate conditions closely as possible. During the euhydrated first urge trial (E1), participants were asked to void at their first urge (2 on the scale). During the euhydrated ad libitum urge (EA), participants were given the freedom to void at any urge.

During the dehydrated trial (2 days), subjects were restricted to a 500 mL bottle of water during the 24 hours. Dietary restrictions include avoiding food high in water content. For the dehydrated first urge trial (D1), participants were asked to void at their first urge (2 on the scale). During the dehydrated ad libitum trial (DA), participants were given the freedom to void at any urge.

The morning after their collection period, participants would visit the Human Performance Laboratory to drop off their samples and confirm they followed the instructions, especially in regards to urgency.

Upon receiving the container within the lab, the urine was analyzed. Measurements included volume, color, osmolality (OSM) and urine specific gravity (USG). Osmolality (OSM) was measured in duplicate using a calibrated freezing-point depression osmometer (Model 3250, Advanced Instruments Inc., Norwood, MA, USA). Urine specific gravity (USG) was measured using a calibrated hand-held refractometer (clinical refractometer 300005, SPER Scientific, Scottsdale, AZ, USA). To classify participants as hydrated or dehydrated, urine specific gravity values set by the American College of Sports Medicine (ACSM) was used. According to these values, individuals with a urine specific gravity ≤ 1.020 are designated as euhydrated, and dehydrated individuals are indicated by a urine specific gravity of >1.020 (6). When the sample USG was 1.020, it was considered hydrated if the osmolality was < 800 mosm/kg. If the osmolality was between 700-800 mosm/kg, we would consider the urine color. If the urine color was 6-7, the sample was considered dehydrated. If the urine color was 1-5, the sample was considered hydrated.

Results

Urinary values for all trials are in Table 1. By using a two-way ANOVA test it was determined that hydration status affects void number (p -value $< .001$), however there is no effect of ad libitum urgency or first urge urgency on void number (p -value = $.50$). Additionally, there is no interaction between hydration status and urge to void instructions on void number (p -value = $.73$) (Figure 1).

The osmolality intraclass correlation coefficient (ICC) among dehydrated trials was 79.06%, which means the level of clinical significance is excellent. The osmolality ICC among hydrated trials is 52.22%, which means the level of clinical significance is fair. The void number ICC among dehydrated trials is 70.34%, which means the level of clinical significance is good. The void number ICC among hydrated trials is 75.97%, which means the level of clinical significance is excellent.

Discussion

The purpose of this study was to determine if urgency affects the validity of void number as a marker of hydration status. Interestingly, even though our subjects were given the freedom to urinate at any urgency level in the “ad libitum” trials, 47% still continued to urge at a 2. More specifically, in the euhydrated ad libitum (EA) trial 60% of the voids were recorded as either more than or less than 2. In the dehydrated ad libitum trial (DA) 44% of the voids were recorded as either more than or less than 2. It would be interesting to see if perhaps having more variance in urgency would still support our findings that urgency does not affect the validity of void number as a marker of hydration status.

Our findings can be used to help bridge the gap in the lack of literature examining ad libitum urgency in relation to using void number as a marker of hydration status. Previous research has shown void number is a valid (5) and reliable (3) indicator of hydration status, although there are limitations in the technique. Individuals often void at varying urge levels throughout the day, especially when a bathroom is not readily accessible. Therefore, our findings suggest that individuals can void at any urgency while using void frequency as a marker of hydration status.

Further investigation might lead to exploration in populations that do not consistently have a bathroom readily accessible (i.e. high school students, truck/bus drivers, etc.). For example, if this experiment were to be conducted on high school students, who generally are expected to only void during class change breaks, could it possibly affect the students likelihood to void at a 2 on ad libitum trial days. Additionally, age would be another factor to consider. Interestingly, Homma et al. found that number of voids a day were greater in older adults, therefore, it opens up the question if void number would still be a valid marker of hydration status in older adults (7). It would be interesting to further examine the effect of different types of fluid intake on void frequency as a marker of hydration status. In our study, the hydrated trials instructions did not provide a specific guideline of amount or type of fluid to ingest, whereas for the dehydrated trial subjects were restricted to 500ml of fluid.

Limitations

One possible limitation to the study was participant adherence to our protocol, specifically with diet. We asked subjects to repeat their meals as closely as possible for all four trials, however, not all subjects were able to do this for a multitude of reasons (i.e. forgot what

they ate, did not have the means to repeat a meal, etc.). Perhaps in future protocols, meals or a budget would be given to subjects for meals on the days of their collection. In order to alleviate forgetfulness, perhaps an online or phone accessible document can be made for subjects to record all four of their trials diet log in one place.

Another possible limitation could be small sample size. A protocol that had more subjects would be able to further validate void frequency as a marker of hydration status.

Conclusion

The purpose of this study was to determine if urgency affects the validity of void number as a marker of hydration status. The findings suggest that void urgency does not ultimately affect the validity of void number as a way to assess hydration status. Therefore, individuals can be instructed to urinate at any level of urgency and the number of times they void in 24 h is still a valid indicator of hydration status.

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Figure Captions

Figure 1: Mean \pm SD number of voids per 24-hr experimental trial period. Significant effect between hydrated and dehydrated trials ($P < .05$), but no effect between ad libitum and first urge ($P > .05$). E1= euhydrated first urge EA=euhydrated ad libitum D1= dehydrated first urge DA= dehydrated ad libitum. Significance, between conditions, are denoted by (*).

Table 1: Mean \pm standard deviation of 24-h urinary measures while hydrated and dehydrated

	<u>Hydrated</u>		<u>Dehydrated</u>	
	First Urge	Ad Libitum	First Urge	Ad Libitum
Urge to Void	2 \pm 1	2 \pm 1	2 \pm 1	2 \pm 1
Void Frequency	7 \pm 3	7 \pm 3	4 \pm 2*	4 \pm 1*
24 -h Volume (ml)	2127.3 \pm 1257.4	2341.5 \pm 1220.4	888.9 \pm 385.3*	860.9 \pm 470.0*
U_{SG}	1.012 \pm .004	1.011 \pm .004	1.023 \pm .003*	1.024 \pm .003*
U_{osm} (mosm/kg)	451 \pm 165	429 \pm 187	878 \pm 133*	895 \pm 143*

*Significant difference between corresponding hydrated trial (p<.001)

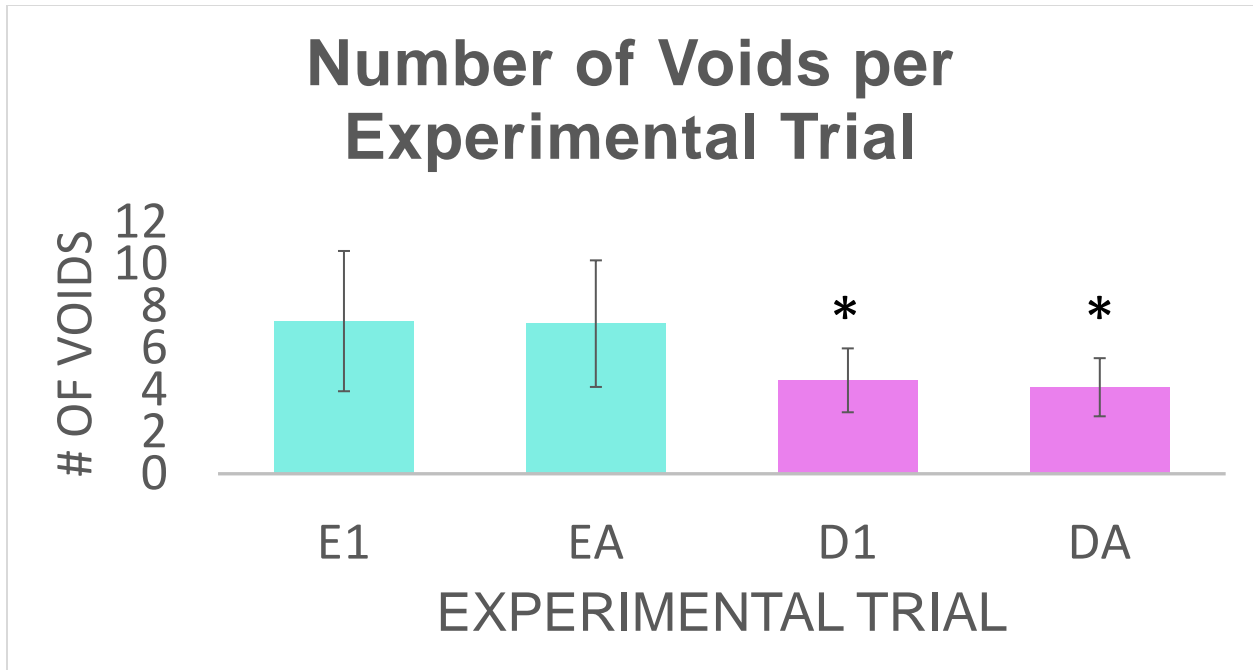


Figure 1: Mean \pm SD number of voids per 24-hr experimental trial period. Significant effect between hydrated and dehydrated trials ($P < .05$), but no effect between ad libitum and first urge ($P > .05$). E1= euhydrated first urge EA=euhydrated ad libitum D1= dehydrated first urge DA= dehydrated ad libitum. Significant difference between corresponding hydrated trial ($p < .001$) denoted by (*).