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Validity of Daytime Urinary Frequency as a Tool for Assessing Hydration

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ABSTRACT

Introduction: It is known that 24-h void number is a valid way to assess hydration status. However, no studies have examined if urinary frequency just during the waking hours (~18 h) is a valid indicator of hydration status. **Purpose:** This study was conducted in order to determine if void number during only the waking hours was a valid indicator of hydration status compared to total voids over a 24-hour period. **Methods:** The subjects in this study consisted of 14 males and 18 females 18-80 yrs old who were healthy and not currently taking any body fluid altering medications. This study consisted of three trials, one familiarization and two experimental. Subjects underwent one dehydrated trial in which fluid intake was limited to 500 mL per day and one hydrated trial in which fluid consumption was encouraged. The subjects were asked to collect all urinary voids in jugs at the moment of first urge. For each void, urgency, thirst, and time of day (making note of which voids occurring during the non-waking hours) were recorded on the side of the jug and the level was marked. **Results:** The number of voids in 24-h while euhydrated and dehydrated was (7 ± 3) and (4 ± 2), respectively. Counting only the waking hour void number yielded a similar void number for both euhydrated and dehydrated (7 ± 3) and (4 ± 2), relative to the 24-h void number ($P > 0.05$). The only factor that effected void number was hydration status (P<. 05). The time of collection had no effect (P= .06), and there was no interaction between collection time and hydration status (P= .057). USG and OSM for the hydrated trial was 451 ± 165 mOsm/kg H_2O and 1.012 ± .004, respectively. USG and OSM for the dehydrated trial was 878 ± 133 mOsm/kg H_2O and 1.023 ± .003, respectively. **Conclusions:** It does not matter if an individual counts total number of voids over 24-h or just waking hour voids; there is only a difference in void number when comparing hydration status. This is important because it means that an individual can just count how many voids they have throughout the course of the day (i.e., waking) for an indicator of hydration status. In this study voiding ~7 times during the day was the average for those in a hydrated state, and ~4 for those in the dehydrated state.

Introduction

Hydration is a key aspect of everyday life; the average human can only survive up to 5 days without water (Popkin, D'anci, & Rosenberg, 2010). However, it is challenging for the body to maintain cellular homeostasis and keep it within a normal range (Sawka, Cheuvront, & Carter, 2005). If the human body does not maintain cellular homeostasis, it is at risk for dehydration. Dehydration in humans can have extremely serious side effects such as a decrease in thermoregulation, cognitive performance, physical performance, gastrointestinal and kidney function, cardiovascular function and many other bodily functions (Popkin, D'anci, & Rosenberg, 2010).

Older individuals are at a greater risk for dehydration versus younger individuals. This is partly because older men tend to possess a lower thirst level compared to younger men. This means they tend to naturally to drink less water on a daily basis and are therefore were more likely to be dehydrated when compared to the younger population (Phillips et al., 1991). However, regardless of age, being well hydrated is essential to everyday cognitive function and the overall health of our bodies (Popkin, D'anci, & Rosenberg, 2010; Fadda et al., 2012).

There are many ways to determine a person's hydration status, including analyzing urine osmolality, urine specific gravity and urine color. These measurements have proven to be good indicators of overall hydration and appear to not be affected by exercise or induced dehydration (Armstrong, Soto, & Hacker, 1999). It has also been shown that void frequency over 24-h is a valid and reliable way to access hydration status in subjects who are both hydrated and dehydrated (Tucker et al., 2016).

Dehydration is studied quite often, however one topic that has only been lightly touched on is the validity of void number. It has been found that the number of voids over 24- h was significantly greater in subjects who were hydrated compared to subjects who were dehydrated (Burchfield et al., 2015) It was also found that a majority of the voids were collected during the hours of 1300 and 0100 in the same study conducted by Burchfield. This could simply be because more people are actively eating and drinking during those hours and therefor need to void more often. It lends the question as to whether simply using the number of voids during the day is suffice to assess hydration status. If valid, it would eliminate the need for individuals to count voids that occur in the middle of the night, which can often be difficult and confusing

We know that 24- h void number is an accurate was to access hydration status (Tucker et al., 2016; Burchfield et al., 2015) However, no studies have shown if the void number during the waking hours is a valid indicator of overall hydration status when compared to total voids over 24-h. Therefore, the purpose of this study is to examine if void number during the waking hours is equally as valid as an indicator of hydration status when compared to total voids over 24-h. We hypothesize that waking hour voids will be just as valid when used as an indicator of hydration status.

Methods

The subjects in this study consisted of 14 males and 18 females ranging from 18-80 years old. The participants were healthy individuals who were free of any medications that could possibly alter body fluid.

The study consisted of two experimental trials and three overall visits to the Human Performance Lab. For one experimental trial, subjects were given 500 mL of fluid to intake within their 24-hour collection period to ensure dehydration. During the other experimental trial, subjects were allowed to drink freely. On the 1st visit, directly after signing a consent form that had been approved by the University of Arkansas, the participant's age, height and body mass were measured. Both the height and the body mass were recorded with the participant wearing no shoes and light clothing. Standing height was measured and recorded to the nearest 0.1 cm. Body mass was measured using a scale (Seca, model: 7701321004, Vogel & Hamburg, Germany or Health-o-meter) and recorded to the nearest 100 g. Participants were then instructed on how to record fluid intake and physical activity with diaries. During both trials participants were asked to record their food, fluid intake, and daily activity. They were also asked to refrain from exercise and alcohol consumption. Caffeine intake was not prohibited, but it was limited to less than 355 mg. Caffeine content of beverages was estimated using the USDA National Nutrient Database for Standard Reference (USDA National Nutrient Database for Standard (http://ndb.nal.usda.gov/)(Tucker et al., 2016)

For the dehydrated trials, participants were given a 500 mL bottle of water and instructed to only drink that during the 24-hour collection period. For the hydrated trials, participants will be encouraged to drink fluid throughout the day and listen to their internal signals to determine the amount of water their body needs. The order of the trials was both randomized and counterbalanced

For each trial, participants were given 2 large urine containers to collect urine over a 24-hour time period. Subjects were instructed to collect their urine in the larger container during the day and night of the collection period. One the day of collection, the subjects were to eliminate their first void of the morning into the toilet, then to begin collecting every void after that into the large container included non-waking voids. When the subjects woke the next morning on the day after their collection began, then were instructed to void their first morning void into a smaller container that was kept separate from the other voids over the last 24-h. The participants were educated on void urgency using a 0-4 urge to void scale, and instructed to void at the first urge to void (the number "2") during the 24-hour collection period (Athwal et al., 2001). The participants were asked to draw a straight line at the level of urine, mark the urge to void, along with the time of the void making note of which voids occurred during non-waking hours, and the thirst level for each void during the 24-hour collection period. Materials were returned to the Human Performance Lab on the same day as the morning collection, and the participants participated in a brief follow-up meeting to ensure they adhered to the instructions.

The sampled were then analyzed for Urine specific gravity (U_{SG}), Urine osmolality (U_{OSM}), and urine volume. U_{SG} was determined on each well-mixed 24-h urine collection using a calibrated hand-held refractometer (clinical refractometer

300005, SPER Scientific, Scottsdale, AZ, USA). U_{OSM} was measured in duplicate using a calibrated freezing point depression osmometer (Model 3250, Advanced Instruments Inc., Norwood, MA, USA). For each trial, subjects were classified as hydrated or dehydrated by the USG and U_{OSM} standards that have been previously determined. (Poposki et al., 200; Armstrong et al., 2010; Bartok et al., 2004)

Statistical analyses was performed using SPSS v. 22 for Windows (IBM Corporation, Somers, NY, USA). Data was reported as mean ± s.d., and an alpha level of 0.05 defined significance for all tests (Burchfield et al., 2015). In order to quantify the timing of voids, the 24-h urine collection period were split into waking voids and non- waking voids as indicated by the subjects. The number of voids, were expressed as a percentage of the total number of 24-h voids for each individual subject, and waking vs 24-h voids were compared. Pearson's product correlations was used to evaluate the relationship between the number of voids and U_{SG} and U_{OSM}. Student's independent t-tests was used to compare the dehydrated and hydrated groups, and results were given as means and s.d's in order to determine if waking voids were an accurate indicator of hydration status when compared to total 24-h voids

Results

There were no significant difference between void urgency and hydrations status There was also no difference between 24-h voids and waking hour voids ($p > .05$) (See figures 1 and 2). The number of 24-h hour voids euhydrated and dehydrated was 7 ± 3 and 4 ± 2, respectively. During the waking hour only the void number for euhydrated and dehydrated was (7 ± 3) and (4 ± 2), respectively.

However, when counting the number of voids for each hydration status, there was a significant effect (i.e. hydrated vs dehydrated) ($p < .001$). People tended to void more when hydrated compared to dehydrated regardless of the time that the void occurred ($p = .06$). Meaning it did not matter if the overnight voids were included in the 24-h analysis, the results were the same ($P= .057$).

From the 24-h samples, we found that osmolality (OSM) for the hydrated trial was 451 ± 165 mOsm/kg H_2O, for the dehydrated trial this number was 878 ± 133 mOsm/kg H_2O.. Urine specific gravity (USG) for the hydrated trial was 1.012 ± .004, for the dehydrated trial this number was 1.023 ± .003.

Discussion

The purpose of this study was to determine if void number during only the waking hours was a valid indicator of hydration status compared to total voids over a 24-hour period. This study was unique in that it took a previously known method of accessing hydration status and simplified it. Instead of having to recall every single void during a 24-h day, we wanted to discover a smaller time frame in which people would have to keep track of their voids.

The main finding of this study was it does not matter if an individual counts total number of voids over 24-h or just waking hour voids. Simply counting just the waking hour voids is enough to determine hydration status. It was found that if a subject voided 7 ± 3 times during their waking hours, then they could classify themselves as hydrated. It was also discovered that if the subject only voided 4 ± 2 times during their waking hour, then they could classify themselves as dehydrated and should take measures to consume more liquid for their body’s health. Similar to our study, previous studied have also found that people who have a higher void frequency over a 24- hour period were more hydrated than those with a lower void rate number (Burchfield et al., 2015).

The only factor of this study that seemed to have an effect on a subjects void number was the hydration status of the subject. When a subject was hydrated, they tended to void significantly more than when they were dehydrated ($p < .001$). In a previous study it was also found the number of voids over 24- h was significantly greater in subjects who were hydrated compared to subjects who were dehydrated (Burchfield et al., 2015).

There have been studies done to determine that the majority of the voids collected by the subjects were during the hours of 1300 and 0100 (Burchfield et al., 2015). However, our study showed that the time of collection did not have an effect on void number ($p = .06$).

Further research should continue to investigate easier and more reliably methods for people to access their hydration status without having to analyze their urine in a lab. Dehydration can have severe negative impacts on the body and can often go unnoticed, especially if a person has a diminished sense of thirst or is highly inactive. A decrease in thermoregulation, cognitive performance, gastrointestinal and kidney function, cardiovascular function is also a huge risk for people who are dehydrated (Popkin, D’anci, & Rosenberg, 2010). Further studies should also be conducted on how to properly educate the population on how to stay hydrated and avoid these negative effects.

Limitations

One possible limitation of this study was independence of the subjects. Some voids could have been missed of not collected at the correct urgency. Some could have been reported falsely due to the amount of time the subjects had to void given certain life circumstances. Also the night time voids could have cause a limitation due to the grogginess of the subject and forgetfulness to remember if they voided overnight or not. Only 3 subjects reported to have voided overnight out of the 32 subjects who participated which is an extremely low number.

Diet can effect hydration status. While subjects were told to mimic their diet from the previous trial, some were unable to or forgot. Also they were asked to avoid foods that were high in water content during the dehydrated trial. If subjects failed to meet the hydration/dehydration cut off, they were asked to redo the trial which caused an error in the randomization of each trial.

Conclusion

The purpose of this study was to determine if void number during only the waking hours was a valid indicator of hydration status compared to total voids over a 24-hour period. We found that it does not matter if an individual counts total number of voids over 24-h or just waking hour voids; there is only a difference in void number when comparing hydration status. This is important because it means that an individual can just count how many voids they have throughout the course of the day (i.e., waking) for an indicator of hydration status. It was found that voiding around 7 times during the day is the average for those in a hydrated state, and around 4 for the those in the dehydrated state.

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Figures

Figure 1: Mean ± SD number of voids during the hydrated trial. There was no difference between 24-h void number and waking hour void number (P= .06).

Figure 2: Mean ± SD number of voids during the dehydrated trial. There was no difference between 24-h void number and waking hour void number (P= .06).

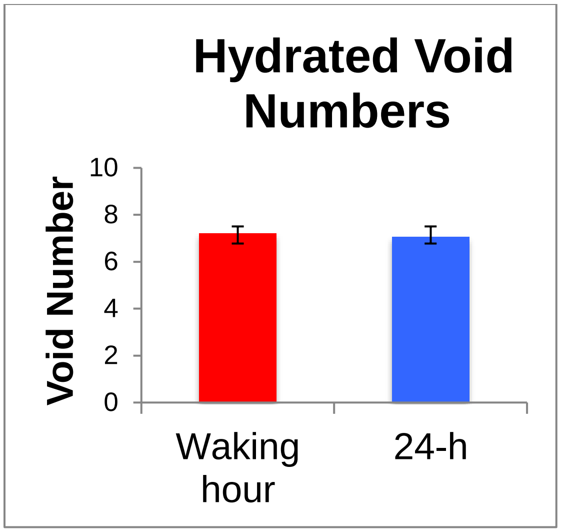

Figure 1.

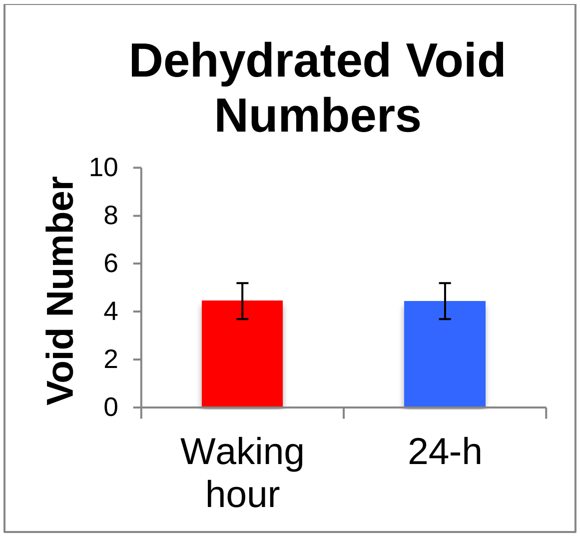
Dehydrated Void Numbers
Void Number
10
8
6
4
2
0
Waking hour
24-h

Figure 2.