

Fluid Hydration Status Assessment in Behavioral Medicine Research: Seven-Day Test-Retest Reliability.

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Introduction:

Adequate hydration is crucial in maintaining optimal physical and mental functioning and the need for a fast and reliable hydration status assessment in behavioral medicine research has become increasingly important. The main goal of this study was to determine the reliability of bioelectrical impedance in assessing total body water (TBW), extracellular water (ECW), and intracellular water (ICW). A second goal was to determine reliability of using TBW, ECW, ICW, hematocrit (Hct), and hemoglobin (Hgb) as markers for identifying chronically hypo-hydrated and hyper-hydrated individuals.

Method:

Participants: One hundred participants (52 males and 48 females) between 18 and 30 years of age were recruited for this study. Participants received research credit in an introductory psychology class. All subjects abstained from eating and drinking for 4 hours prior to the study and from alcohol and physical exercise for 12 hours prior to the study.

Physiological Measures:

Bioelectrical impedance: TBW, ECW, and ICW were assessed using a **BodyStat MultiScan 5000** bioelectrical impedance monitor. The MultiScan 5000 is a multi-frequency impedance monitor that assesses TBW by using a 200 kHz signal and ECW by using a 5 kHz. Intracellular water is determined arithmetically by subtracting ECW from TBW. TBW, ECW, ICW are expressed in liters of water

Blood measures: Hematocrit and hemoglobin were assessed via finger capillary puncture.

Procedure:

Participants were scheduled for two laboratory sessions within a seven-day period. During the initial session, informed consent was obtained, weight and height were measured. Next, participants were asked to lie supine on a massage table and two electrodes were placed on the participant's right hand at the levels of the metacarpophalangeal joint and the radiocarpal joint, and two electrodes were placed on the right foot near the head of the metatarsals and the ankle joint. Participants then rested quietly for ~25 minutes. Blood samples were collected from a finger stick of the left hand 10 minutes into the testing period. Bio-impedance assessment started at the 20-minute mark. Following the first session, participants were instructed to return to the laboratory 7-days later. All procedures were repeated during session 2.

Statistical Analyses:

Pearson's correlations were used to assess the reliability of TBW, ECW, and ICW across test session 1 and 2. Correlations were also used to assess the reliability of Hct and Hgb. In order to

assess the reliability of hypo-hydrated and hyper-hydrated group classifications, quartiles were calculated for males and females separately due to the percentage of TBW being higher in men than women. TBW, ICW, and ECW correlations were then conducted within each the upper and lower quartile group.

Results:

Test-retest Reliability:

Full Sample: For the full sample, all the body water and blood measures were significantly correlated for visits 1 and 2. Significant reliability was found for TBW ($r=.99$, $p<.0001$, $n=100$), ECW ($r=.99$, $p<.0001$, $n=99$), and ICW ($r=.99$, $p<.0001$, $n=99$).

In order to account for body weight differences, the percentage of body water by weight was calculated (liters/kg). TBW ($r=.97$, $p<.0001$, $n=100$), ECW ($r=.95$, $p<.0001$, $n=99$), and ICW ($r=.99$, $p<.0001$, $n=99$) by weight were also reliable over time. Hematocrit ($r=.89$, $p<.001$, $n=79$) and hemoglobin ($r=.41$, $p<.001$, $n=80$) were also reliable.

Males: For males, TBW by weight ($r=.94$, $p<.0001$, $n=52$), ECW by weight ($r=.94$, $p<.0001$, $n=51$), ICW by weight ($r=.94$, $p<.0001$, $n=51$), and Hct ($r=.69$, $p<.001$, $n=42$) were reliable over a one week period. The correlation for hemoglobin was not significant.

Females: Females showed patterns similar to those of males with TBW by weight ($r=.97$, $p<.0001$, $n=48$), ECW by weight ($r=.97$, $p<.0001$, $n=48$), ICW by weight ($r=.96$, $p<.0001$, $n=48$), and Hct ($r=.82$, $p<.001$, $n=37$) being reliable over time. Hemoglobin was marginally significant ($r=.30$, $p<.07$, $n=38$).

Hypo- and Hyper-hydration Status Reliability:

In terms of hypo-hydration and hyper-hydration grouping, the cutoff for males in hypo-hydrated group was 51.35% and the hyper-hydration cutoff was 55.77%. For females, the cutoff for being hypo-hydrated was 45.0% and 49.35% for the hyper-hydration group.

Hypo-hydrated males. For the hypo-hydration status males, TBW ($r=.98$, $p<.0001$, $n=13$), ECW ($r=.97$, $p<.0001$, $n=13$), and ICW ($r=.99$, $p<.0001$, $n=13$) were shown to be reliable over a one week period. Hematocrit was also reliable over a one week period ($r=.69$, $p<.01$, $n=12$), although hemoglobin was not reliable.

Hyper-hydrated males. For the hyper-hydration status males, TBW ($r=.99$, $p<.001$, $n=13$), ECW ($r=.98$, $p<.001$, $n=13$), and ICW ($r=.99$, $p<.001$, $n=13$) were reliable over a one week period. Hematocrit and hemoglobin were not found to be reliable across test sessions.

Hypo-hydrated females. For the hypo-hydration status females, TBW ($r=.97$, $p<.0001$, $n=12$), ECW ($r=.95$, $p<.0001$, $n=12$), ICW ($r=.97$, $p<.0001$, $n=12$), and Hct ($r=.91$, $p<.001$, $n=10$) were found to be reliable across time. The correlation for hemoglobin was not significant.

Hyper-hydrated females. For the hyper-hydration status females, TBW ($r=.97$, $p<.0001$, $n=12$), ECW ($r=.96$, $p<.0001$, $n=12$), ICW, ($r=.97$, $p<.0001$, $n=12$), and Hct ($r=.90$, $p<.002$, $n=8$) were reliable over a one week period. Hemoglobin was not significant.

Discussion:

The present findings demonstrate that fluid hydration status, as indexed by bioelectrical impedance, is reliable across time and is also reliable within individuals who are chronically hyper-hydrated and hypo-hydrated. Furthermore, bioelectrical impedance can be used to accurately determine if a person is chronically hypo-hydrated or hyper-hydrated. The results of this study indicate that body water assessments using bio-impedance techniques afford a fast and

reliable method for evaluating hydration status in behavioral medicine research. Bio-impedance will also allow researchers to assess individual differences in hydration status and its potential influence on cardiovascular reactivity and stress-hemoconcentration.