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Research report

Habitual total water intake and dimensions of mood in healthy young women ☆

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ABSTRACT

Acute negative and positive mood states have been linked with the development of undesirable and desirable health outcomes, respectively. Numerous factors acutely influence mood state, including exercise, caffeine ingestion, and macronutrient intake, but the influence of habitual total water intake remains unknown. The purpose of this study was to observe relationships between habitual water intake and mood. One hundred twenty healthy females (mean ± SD; age = 20 ± 2 y, BMI = 22.9 ± 3.5 kg·m^{-2}) recorded all food and fluids consumed for 5 consecutive days. Investigators utilized dietary analysis software to determine Total Water Intake (TWI; total water content in foods and fluids), caffeine, and macronutrient consumption (i.e. protein, carbohydrate, fat). On days 3 and 4, participants completed the Profile of Mood State (POMS) questionnaire, which examined tension, depression, anger, vigor, and confusion, plus an aggregate measure of Total Mood Disturbance (TMD). For comparison of mood, data were separated into three even groups (n = 40 each) based on TWI: low (LOW; 1.51 ± 0.27 L/d), moderate (MOD; 2.25 ± 0.19 L/d), and high (HIGH; 3.13 ± 0.54 L/d). Regression analysis was performed to determine continuous relationships between measured variables. Group differences ($p < 0.05$) were observed for tension (MOD = 7.2 ± 5.4, HIGH = 4.4 ± 2.9), depression (LOW = 4.5 ± 5.9, HIGH = 1.7 ± 2.3), confusion (MOD = 5.9 ± 3.4, HIGH = 4.0 ± 2.1), and TMD (LOW=19.0 ± 21.8, HIGH=8.2 ± 14.2). After accounting for other mood influencers, TWI predicted TMD ($r^2 = 0.104$; $p = 0.050$). The above relationships suggest the amount of water a woman consumes is associated with mood state.

Introduction

Chronic negative mood states (traits) can result in physiological dysfunction and reduced quality of life (Kubzansky, Cole, Kawachi, Vokonas, & Sparrow, 2006; Kubzansky & Kawachi, 2000). Mounting evidence suggests even transient negative mood states (e.g., anxiety and anger) impact physiological dysfunction, including the development of coronary heart disease (Kubzansky & Kawachi, 2000). Meanwhile, positive mood states appear to promote health, including but not limited to improved pregnancy outcomes and increased longevity (Pressman & Cohen, 2005).

Few investigations have examined acute water restriction and body water reduction (i.e., mild dehydration) on mood in healthy, young men and women, which resulted in elevated fatigue, confusion and tension with decreased vigor (Armstrong et al., 2012; Ganio et al., 2011; Pross et al., 2012). Two investigations to our knowledge have examined acute water boluses that did not result in changes in mood parameters (Edmonds, Crombie, Ballieux, Gardner, & Dawkins, 2013; Edmonds, Crombie, & Gardner, 2013). Even fewer studies have examined the relationship between habitual total water intake across days (TWI; total moisture in solid foods plus water and beverages) and mood; the simple act of changing drinking behavior might contribute to improved mood state. Further, little consideration has been given to other mood altering activities during examination of water intake on mood state, such as exercise habits (Hamer, Endrighi, & Poole, 2012; Larun, Nordheim, Ekeland, Hagen, & Heian, 2006), caffeine ingestion (Clementz & Dailey, 1988; Lieberman, Spring, & Garfield, 1986), and macronutrient intake (Kien et al., 2013; Leathwood & Pollet, 1982; Lieberman et al., 1986; Spring, Lieberman, Swope, & Garfield, 1986). Therefore, this investigation observed the relationship between habitual

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24 h TWI and mood, and accounted for multiple mood-altering factors, in healthy young women undertaking usual daily activities. We hypothesized that after accounting for exercise and dietary variables, low habitual 24 h TWI would adversely relate to mood dimensions, similar to previous acute water restriction studies (Armstrong et al., 2012; Ganio et al., 2011; Pross et al., 2012).

Materials and methods

Participants

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human participants were approved by the University Institutional Review Board. Prior to testing, each participant read and signed an informed consent document. One hundred twenty healthy, college-aged females participated in this study (age = 20 ± 2 y, mass = 62.1 ± 11.0 kg, height = 164 ± 7 cm, BMI = 22.9 ± 3.5 kg/m^2 (97 "normal weight," 17 "overweight," and 6 "obese"; lean body mass likely contributed to elevated BMI given many of the participants regularly exercised)). All women used oral contraceptives for at least two months prior to enrolling; recruiting women who used combination drug (estradiol and progestin) oral contraceptives promoted hormonal homogeneity among participants to reduce fluctuations of total body water during observations and provided ecological validity. No participant reported any mood or fluid regulatory related disorder.

Testing protocol

A familiarization/baseline visit served to collect measures of height and weight, and verify the use of an acceptable oral contraceptive and introduce subsequent testing procedures including questionnaires. Additionally, participants were instructed on how to accurately record all food and fluid consumed during a 24 h period, and to maintain their regular diet during their participation with the exception of alcoholic beverage consumption, which they refrained from for the duration of their participation to avoid fluid balance and mood fluctuations. Testing occurred over 5 consecutive days. Participants returned to the laboratory each morning on each of the 5 days between 0530 h and 0800 h to review the previous day's diet record with a nutrition counselor. Diet records averaged over 5 consecutive days (compared to fewer days) permitted a more accurate representation of participants' typical dietary intake. Habitual total water intake (TWI; total water content in solid foods + fluid, calculated by moisture content analysis), caffeine ingestion, and macronutrient consumption (i.e. protein, carbohydrate, fat) were determined via commercial software (Nutritionist Pro™, Axxya Systems, Stafford TX).

Questionnaires

Prior to data collection days, participants were introduced to all questionnaires and how to properly complete them. On testing days 3 and 4 (of 5), participants were asked to complete the Profile of Mood State questionnaire (POMS; McNair, Lorr, & Droppleman, 1981) and rate their perception of thirst on a scale of one to nine (one representing not thirsty at all, and nine representing very very thirsty) (Engell et al., 1987). Having participants complete the same questionnaires on two consecutive days (which were averaged for analyses) reduced inaccurate perceptions of mood associated with unique and influential events on a given day and/or a new environment (which might have existed on earlier testing days) and any potential feelings of inconvenience (which might have existed on testing day 5). Participants circled one numerical value on the POMS questionnaire that best represented the extent to which they experienced the mood descriptor at that particular moment using the validated paper questionnaire. Participants were provided with a list of definitions for each of the mood descriptors, and they were asked to complete the questionnaire in numerical order (mood descriptors 1 through 65). The POMS questionnaire was administered in the same quiet, well lit room on the university campus with stable environmental conditions for every administration.

The POMS inventory is widely accepted in psychological research and is sensitive to numerous environmental stressors, including water restriction. The POMS is a 5-point self-administered scale that assesses 6 mood states: tension-anxiety (Tension), depression-dejection (Depression), anger-hostility (Anger), vigor-activity (Vigor), and confusion-bewilderment (Confusion). Greater values for POMS variables represent greater perceived mood state. The aggregate variable in the POMS inventory, total mood disturbance (TMD), represents the sum of negative and positive mood subscale scores. Thus, a large TMD value represents a negative mood state.

Personal characteristics

Acknowledging that numerous variables in addition to macronutrient intake likely influence mood state, participants were asked to provide information regarding their current illnesses, use of prescription drugs, supplements and vitamins, typical consumption of alcoholic beverages, family medical history (conditions that are considered hereditary risk factors for disease), and intentional exercise (mode, frequency, duration, and how long they had been practicing these habits). This information was collected on a medical history questionnaire created by university physicians; information recorded on this questionnaire was reviewed with a physician. The items collected allowed investigators to consider the influence of behaviors and predispositions on mood state.

Statistical analyses

All participants (n = 120) were evenly separated into 3 groups, on the basis of habitual TWI derived from averaged 5 d dietary records: low (LOW; n = 40), moderate (MOD; n = 40), and high (HIGH; n = 40) TWI. Macronutrient data were converted from grams per day to percentage of kilocalories (kcal) for analyses. Data analyses were performed with statistical software (SPSS version 19.0, IBM Corporation, Champaign, IL). Descriptive data (mean ± SD) were calculated for all outcome variables. Comparisons were made among groups via one-way analysis of variance (ANOVA) for all dependent variables (i.e., personal characteristics, dietary macronutrients, thirst, and POMS scores). In the event of a significant F statistic, *post hoc* multiple comparisons were performed using a Bonferroni correction for three comparisons. Investigators conducted multiple regression analyses to examine the influence of TWI on POMS category scores, above and beyond the impact of variables known to influence mood state (i.e., exercise, caffeine and macronutrient intake). In other words, the variance in POMS scores attributable to water intake was isolated by first accounting for the variance from other mood influencers; taking these influencers into account allowed for a conservative examination of water intake on mood. An average of thirst and POMS values from days 3 and 4 was used for all statistical analyses.

Results

The mean (±SD) absolute and relative to body mass TWI for all 120 women was 2.30 ± 0.76 L/d and 37 ± 13 ml/kg/d, respectively, and these women exhibited a continuous habitual TWI range (Fig. 1). MOD (2.25 ± 0.19 L/d) approximated daily water intake recommended for adult women put forth by the Institute of Medicine