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Correlation Between Water Intake, Memory, Cognitive, and Stress Levels of Healthy Students: A Cross-sectional Study

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ABSTRACT

Background: Adequate water intake is essential for physiological and psychological body functions. However, evidence has found that self-reported water intake and cognitive and stress outcomes among university students remains limited. This study examined the association between daily water intake, self-perceived memory performance, and stress levels among university students in Jordan.

Methods: A cross-sectional study was conducted among 263 students aged between 17–50 years at the Applied Science Private University (ASU). A validated, structured self-administered online questionnaire was used, including demographic data, water and fluid intake, and two validated questionnaires, the Arabic versions of the Multifactorial Memory Questionnaire (MMQ) and Perceived Stress Scale-10 (PSS-10). Data were analyzed using descriptive statistics and Pearson or Spearman correlation tests, with statistical significance set at $p < 0.05$.

Results: Student mean daily water intake showed a significant positive correlation with memory satisfaction ($r = 0.213$, $p = 0.001$), perceived memory ability ($r = 0.140$, $p = 0.024$), and use of memory strategies ($r = 0.134$, $p = 0.030$). Higher water intake was also associated with lower stress level ($r = –0.179$, $p = 0.004$). Most students (69.5%) experienced moderate stress and reported average memory satisfaction (74.4%). Consumption of flavored water products was linked to lower memory satisfaction and ability scores ($r = -0.144$, $p = 0.025$).

Conclusion: Greater self-reported water intake was associated with better memory and lower stress levels among university students. Public-health strategies encouraging regular water intake, such as campus hydration stations and refillable bottles, may enhance students' wellbeing.

Keywords: cognitive performance, hydration, perceived stress, university students.

Introduction

Maintaining adequate water intake is critical for sustaining optimal physiological and cognitive functioning (1). Water constitutes approximately 60–70% of total body weight and plays a fundamental role in numerous biological processes, including thermoregulation, nutrient transport, cellular metabolism, and waste elimination (1,2). Proper hydration is essential for maintaining homeostasis, supporting cardiovascular function, and ensuring efficient biochemical reactions within the body. Even mild dehydration, defined as a body water loss of only 1–2%, has been shown to negatively affect cognitive performance, particularly attention, short-term memory, and executive function, while also increasing perceived stress and fatigue (3,4). These subtle impairments may significantly impact daily functioning, especially in populations exposed to high cognitive demands.

International health organizations have established general recommendations to promote adequate hydration. The European Food Safety Authority and the World Health Organization suggest a total daily water intake of approximately 2.0 liters for women and 2.5 liters for men under normal environmental and activity conditions (5). However, these recommendations may vary depending on factors such as physical activity level, dietary composition, and climate. In warmer regions, such as the Middle East, water requirements may be higher due to increased fluid loss through sweating, making adequate hydration even more essential for maintaining both physical and mental performance.

Emerging evidence suggests that water intake may influence brain structure and function through multiple physiological mechanisms (4). Neuroimaging studies have demonstrated that dehydration can lead to temporary reductions in brain volume and cortical thickness, changes that are reversible following rehydration (6). Additionally, hydration status has been linked to alterations in neurotransmitter activity, particularly serotonin, dopamine, and acetylcholine, which are critical for regulating mood, attention, and memory processes (7,8). These neurochemical changes may explain the observed associations between inadequate hydration and declines in cognitive performance. Furthermore, hydration appears to play a role in the regulation of stress responses through hormonal pathways, including the modulation of cortisol secretion, a key hormone involved in stress and emotional regulation (9).

University students represent a population that is particularly vulnerable to inadequate hydration. Academic pressures, irregular daily routines, prolonged sedentary behavior, and frequent consumption of caffeinated beverages may all contribute to suboptimal fluid intake. In countries with hot climates, such as Jordan, these challenges are further exacerbated by environmental conditions that increase the risk of dehydration. Despite this, hydration habits are often overlooked in health research involving student populations. Previous studies conducted in Jordan have primarily focused on dietary patterns, obesity, and psychological stress (10), with limited attention given to hydration status as a contributing factor to cognitive and mental health outcomes.

Therefore, this study aims to address this gap in the literature by examining the relationship between daily water intake, self-perceived memory performance, and stress levels among university students in Jordan. By exploring these associations, the study seeks to provide new insights into the potential role of hydration in cognitive and psychological well-being. The findings may contribute to the development of targeted health promotion strategies and educational interventions aimed at improving hydration behaviors, ultimately enhancing academic performance and overall quality of life among university students.

This study aimed to identify the key prognostic factors in elderly patients with astrocytoma using advanced statistical analysis and ML. Additionally, we are developing a user-friendly web-based AI tool that allows clinicians to generate real-time survival predictions, supporting treatment strategies of elderlies.

Methods

Study Design and Setting

A cross-sectional study was conducted between April 8 and May 6, 2025, at the Applied Science Private University (ASU). This design was selected as an efficient approach to assess relationships between hydration status and cognitive and psychological outcomes within a defined population at a single point in time.

Participants and Sampling

Participants were recruited using a convenience sampling method through voluntary online questionnaires distributed via university email systems and social media platforms commonly used by students, such as WhatsApp and Instagram. The inclusion criteria required participants to be currently enrolled undergraduate students at ASU and free from any diagnosed neurological, psychiatric, or major chronic medical conditions that could influence cognitive function or hydration status. Students who did not meet these criteria or submitted incomplete questionnaires were excluded from the analysis.

Ethical Considerations

All participants provided electronic informed consent before participation. The study ensured confidentiality and anonymity by not collecting identifying information. Participation was entirely voluntary, and respondents were informed of their right to withdraw from the study at any point before submission without any consequences.

Data Collection Tools

Data were collected using a structured, self-administered questionnaire composed of four main sections. The first section gathered demographic and lifestyle information, including age, sex, faculty, academic year, place of residence, monthly income, smoking status, physical activity level, and dieting behaviors. These variables were included to control for potential confounding factors that might influence hydration, stress, or cognitive performance.

The second section assessed hydration-related behaviors, including daily water intake, total fluid consumption, number of glasses consumed per day, and the use of flavored or detox water products. This section aimed to capture both quantity and patterns of fluid intake among participants.

The third section evaluated perceived stress using the Arabic version of the 10-item Perceived Stress Scale (PSS-10), a widely validated instrument for assessing psychological stress (10). The total PSS -10 score ranges from 0 to 40**,** with higher scores indicating greater perceived stress. The final section assessed memory performance using the Arabic version of the Multifactorial Memory Questionnaire (MMQ), which includes three subscales: Satisfaction, Ability, and Strategy (11). The MMQ was culturally adapted using a forward–backward translation approach and reviewed by experts to ensure linguistic clarity and cultural appropriateness. A pilot study was conducted among participants from the target population to assess item clarity and comprehensibility before the main study. The questionnaire demonstrated good internal consistency (Cronbach's $\alpha = 0.80$) and assessed Satisfaction, Ability, and Strategy domains. Higher scores on these subscales indicate better self-reported memory satisfaction, perceived memory ability, and the use of memory-enhancing strategies.

Data Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics, including means, standard deviations (SD), frequencies, and percentages, were used to summarize participants' demographic characteristics, lifestyle factors, and hydration habits. Incomplete questionnaires were excluded, and hydration data were screened for implausible outliers. Normality of continuous variables (water intake, MMQ, PSS-10) was assessed using Shapiro–Wilk tests and visual inspection; normally distributed data were reported as mean ± SD, skewed data as median (IQR). Pearson correlation tests were used to assess associations between daily water intake (mL/day), total fluid intake, body weight, BMI, and MMQ subscale scores (Satisfaction, Ability, and Strategy). Spearman's rank correlation tests stress level classification, water intake classification, and categorical hydration behaviors (e.g., use of flavored/detox water). Statistical significance was set at $p < 0.05$.

Results

A total of 263 students participated in the study. Most participants were female (74.50%), with ages ranging from 17 to 50 years (mean age = 21.70 ± 2.60 years). Approximately 60.40% of students were enrolled in medical faculties, and 44.10% were in their first academic year. Most students (78.30%) lived with their families, and 72.60% reported not using medications. Also, 24.80% were smokers, and 36.90% reported a sedentary lifestyle. Table 1 summarizes the main demographic and lifestyle characteristics.

Table 1. Demographic and lifestyle characteristics of study participants (n = 263).

Variable	Category / Unit	n (%) *
Sex	Male	67 (25.50)
	Female	196 (74.50)
Age (mean ± SD)	----	21.7 ± 2.60
Study year	First	116 (44.10)
	Second	65 (24.70)
	Third	31 (11.80)
	Fourth	44 (16.70)
	Fifth	4 (1.60)
	Sixth	3 (1.50)
Faculties	Medical	159 (60.40)
	Non-medical	104 (39.60)
Place of residence	Apartment	38 (14.50)
	University dormitory	19 (7.20)
	With family	206 (78.30)
Medications / supplements use	No	191 (72.60)
	Yes	72 (27.40)
Chronic disease	No	254 (96.60)
	Yes	9 (3.40)
Dieting	No	217 (82.50)
	Yes	46 (17.40)
Dieting period	A month or less	27 (10.30)
	2-3 months	18 (6.80)
	4-5 months	7 (2.70)
	6 months or more	12 (4.60)
	Didn't follow a diet	199 (75.70)
Smoking	Smoker	71 (24.80)
	Non-smoker	192 (73.00)
Physical activity	Sedentary	97 (36.90)
	Lightly active	96 (36.50)
	Moderately active	60 (22.80)
	Very active	10 (3.80)

* Values are presented as frequencies and percentages.

Table 2 demonstrates the comparison of hydration-related characteristics between male and female students. Daily water intake showed a statistically significant difference between sexes ($p = 0.001$), whereas total beverage intake ($p = 0.150$), number of glasses of water consumed per day ($p = 0.156$), and use of flavoured/detox water products ($p = 0.582$) showed no statistically significant differences.

Table 3. Psychological stress and memory-related scale measures according to gender among university students (n = 263). The mean PSS-10 score was 18.60 ± 5.20 among males and 19.50 ± 4.10 among females ($p = 0.42$). MMQ Satisfaction scores were 3.80 ± 0.90 and 4.00 ± 0.90 ($p = 0.71$), MMQ Ability scores were 4.10 ± 1.00 and 4.50 ± 1.00 ($p = 0.77$), and MMQ Strategy scores were 3.60 ± 0.80 and 4.60 ± 0.80 ($p = 0.04$) for males and females, respectively. Values are presented as mean ± SD. $p < 0.05$ indicates statistical significance.

Table 2. Hydration and fluid intake characteristics of participants according to sex (n = 263).

Variable	Male (n=67) *	Female (n=196) *	P value
Weight (kg)	67.38 ± 12.60	65.38 ± 12.60	0.591
Water intake (mL/day)	1991 ± 432	2000 ± 432	0.000 **
Total beverage intake (mL/day)	1488 ± 210	1480 ± 210	0.150
Number of glasses of water/day	2.00 ± 1.00	2.13 ± 1.00	0.156
Use of water flavorings/detox drinks (cup/day)	0.66 ± 0.40	1.36 ± 0.40	0.0582

* Values are presented as mean ± SD.

** P < 0.05 indicates statistical significance.

Table 3. Psychological and memory-related scale measures according to gender among university students (n = 263).

Variable *	Male (n = 67) **	Female (n = 196) **	P value
PSS-10 score	18.60 ± 5.20	19.50 ± 4.10	0.420
MMQ Satisfaction score	3.80 ± 0.90	4.00 ± 0.90	0.710
MMQ Ability score	4.10 ± 1.00	4.50 ± 1.00	0.770
MMQ Strategy score	3.60 ± 0.80	4.60 ± 0.80	0.040 ***

* MMQ = Multifactorial Memory Questionnaire; PSS-10 = Perceived Stress Scale-10.

** Values are presented as mean ± SD.

*** p < 0.05 indicates statistical significance.

Table 4 presents the correlation analysis between anthropometric and hydration-related variables with memory performance and hydration behaviors among university students (n = 263). Weight and BMI showed no significant correlations with MMQ domains or water intake measures. Hydration classification was positively correlated with water intake (r = 0.165, p = 0.007), use of water flavorings/drinks (r = 0.181, p = 0.003), and number of glasses of water consumed per day (r = 0.233, p = 0.001). In addition, hydration classification was negatively correlated with MMQ Satisfaction score (r = −0.179, p = 0.004). Correlation coefficients (r) and p-values are presented in the table.

Table 4. Correlations between hydration variables, memory performance, and stress levels among university students.

Variable	Outcome measure	Correlation coefficient (r) *	P value
Weight (kg)	Water intake	-0.023	0.708
	MMQ Strategy	0.013	0.828
	MMQ Ability	-0.021	0.741
	MMQ Satisfaction	-0.085	0.172
	Use of water flavorings/drinks	-0.144	0.020
	Number of glasses of water/day	0.018	0.775
BMI (kg/m²)	Water intake	-0.034	0.585
	MMQ Strategy	0.023	0.716
	MMQ Ability	-0.081	0.193
	MMQ Satisfaction	-0.002	0.978
	Use of water flavorings/drinks	0.078	0.208
	Number of glasses of water/day	0.044	0.484

Table 4, Cont. Correlations between hydration variables, memory performance, and stress levels among university students.

Variable	Outcome measure	Correlation coefficient (r) *	P value
Hydration classification	Water intake	0.165	0.007 **
	MMQ Strategy	0.113	0.069
	MMQ Ability	-0.084	0.176
	MMQ Satisfaction	-0.179	0.004 **
	Use of water flavorings/drinks	0.181	0.003 **
	Number of glasses of water/day	0.233	0.001 **

* Pearson's or Spearman's correlation coefficients are shown.

** $P < 0.05$ indicates statistical significance.

Discussion

This cross-sectional study conducted among university students at ASU demonstrated that higher daily water intake was significantly associated with better self-reported memory outcomes, including memory satisfaction, perceived memory ability, and the use of memory strategies. Additionally, an inverse relationship was observed between water intake and perceived stress levels, indicating that students who consumed more water tended to report lower stress. The majority of participants experienced moderate stress levels and reported average memory performance across all MMQ domains. Interestingly, students who reported using flavored or detox water instead of plain water tended to have lower scores in memory satisfaction and ability. These findings collectively suggest that hydration status may play an important role in both cognitive and psychological well-being among young adults.

The present findings are consistent with previous literature suggesting that hydration status influences cognitive performance, particularly in domains such as attention, working memory, and executive function (12). Even mild dehydration has been shown to impair cognitive performance and mood, especially in demanding academic environments (13). The average water intake observed in this study (approximately 1.99 ± 0.66 L/day) is close to, but slightly below, commonly recommended intake levels, indicating that a proportion of students may not be adequately hydrated. This suboptimal intake could partially explain the moderate stress levels and only average cognitive performance reported by most participants (14).

From a physiological perspective, hydration plays a critical role in maintaining optimal brain function. The brain is highly sensitive to changes in fluid balance, and even slight reductions in hydration can affect neuronal activity. A study has shown that short-term dehydration leads to measurable reductions in brain volume and alterations in cortical thickness, likely due to osmotic shifts and changes in cell volume regulation (15). Importantly, these changes are reversible upon rehydration, supporting the idea that adequate fluid intake is essential for maintaining structural and functional brain integrity (16). Furthermore, improved hydration has been linked to enhanced cerebral blood flow, which may facilitate better oxygen and nutrient delivery to brain tissues, thereby supporting cognitive processes (17).

The positive associations observed between water intake and memory satisfaction, ability, and strategy use in this study may also be explained by improved mental clarity and reduced fatigue associated with adequate hydration (18). Students who are well-hydrated may be more alert, better able to concentrate, and more likely to engage in effective memory strategies, such as organization and rehearsal techniques (19). Although the correlation coefficients observed were modest, they were statistically significant, suggesting that hydration contributes as one of several factors influencing cognitive performance.

In addition to cognitive benefits, the relationship between hydration and stress observed in this study is noteworthy. The significant negative correlation between water intake and stress levels ($r = -0.179$, $p = 0.004$) aligns with existing evidence indicating that dehydration can increase physiological stress responses. Specifically, inadequate hydration has been associated with elevated cortisol levels, increased heart rate, and heightened perceptions of anxiety and tension (20). Therefore, maintaining adequate hydration may serve as a simple and accessible strategy to help mitigate stress, particularly in academic settings where students frequently encounter psychological pressure (21).

The finding that students consuming flavored or detox water reported poorer memory outcomes compared to those consuming plain water warrants further consideration. This association may reflect differences in beverage composition, particularly the presence of added sugars or artificial sweeteners (20,22). Some studies suggest that high intake of sugar-sweetened beverages is associated with poorer cognitive performance and memory decline over time (23,24). Alternatively, this finding may be influenced by confounding lifestyle factors, such as overall diet quality or health awareness (22). Students who prefer plain water may also engage in other health-promoting behaviors that positively affect cognitive function. Due to the cross-sectional nature of this study, causal relationships cannot be established, and further research is needed to clarify these associations.

From a public health perspective, the findings highlight the importance of promoting adequate hydration among university students. Many students may not be aware of recommended intake levels or may neglect hydration due to busy academic schedules (25). General guidelines suggest a daily water intake of approximately 2.0 L for females and 2.5 L for males under normal conditions, although individual requirements may vary depending on factors such as physical activity, climate, and diet (26). Universities could play a role in encouraging healthy hydration habits by increasing access to drinking water, promoting awareness campaigns, and integrating hydration education into student wellness programs (27).

Despite its strengths, including a relatively large sample size and the use of validated instruments (PSS-10 and MMQ), this study

has several limitations. The cross-sectional design restricts causal inference between hydration and cognitive or psychological outcomes. Reliance on self-reported data may introduce recall bias or reporting inaccuracies. The sample was drawn from a single university, limiting generalizability to broader populations. Future research should employ longitudinal or experimental designs to establish causality, recruit more diverse populations across multiple institutions, and incorporate additional lifestyle factors such as diet, sleep, and physical activity. Moreover, objective hydration measures (e.g., urine osmolality) would strengthen the evidence base and reduce reliance on self-report.

Conclusion

There was a significant association between higher water intake and cognitive performance, suggesting that adequate water intake may be associated with mental function and stress levels. It provides a valuable understanding of the importance of water intake in supporting cognitive health among young adults. These results highlight the need for increased awareness about water intake among university students and the potential role of water for enhancing academic and mental health.

Ethical approval

Institutional Review Board of the Faculty of Allied Medical Sciences at ASU (IRB No. AMS-2025-22).

Conflict of interest

The authors declare no conflict of interest.

Author contributions

Conceptualization; A.A. **Methodology;** A.A. **Supervision;** A.A. **Formal analysis;** A.A. **Investigation;** Z.A, F.A, H.A. **Data Curation;** Z.A, F.A, H.A. **Validation;** Z.A. **Visualization;** H.A. **Writing – Review & Editing;** H.A. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

Availability of data and materials

All data used in the study are available upon request.

Supplemental Material

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