Drinking plain water is associated with decreased risk of depression and anxiety in adults: Results from a large cross-sectional study

Fahimeh Haghighatdoost, Awat Feizi, Ahmad Esmaillzadeh, Nafiseh Rashidi-Pourfard, Ammar Hassanzadeh Keshteli, Hamid Roohafa, Payman Adibi

Observational Study

Design and data collection

Haghighatdoost FH and Feizi A contributed to statistical analysis, data interpretation and manuscript drafting; Esmaillzadeh A contributed to SEPAHAN study concepts and design, data collection and drafting of the manuscript; Rashidi-Pourfard N contributed to statistical analysis, data interpretation and manuscript drafting; Keshteli AH, Roohafa H and Adibi P contributed to SEPAHAN study concepts and design, data collection and drafting of the manuscript; Feizi A supervised the current secondary study; all authors approved the final version of the manuscript.

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Correspondence to: Awat Feizi, PhD, Full Professor, Psychosomatic Research Center, Integrative Functional Gastrointestinal Research Center and Biostatistics and Epidemiology Department, School of Health Isfahan University of Medical Sciences, Hezarjarib, Isfahan 81746-73461, Iran. awat_feizi@hlth.mui.ac.ir

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Evidence supports the relation between September 20, 2018

Scale was used to assess anxiety and depression. Iranian version of the Hospital Anxiety and Depression

Core tip: Evidence supports the relation between water consumption and health outcomes. Validated Iranian version of the Hospital Anxiety and Depression Scale was used to assess anxiety and depression.

CONCLUSION

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INTRODUCTION

The prevalence of common psychological disorders has been increasing over recent decades[1,2]. Approximately, 29.2% of people are suffering from one of the common mental disorders worldwide[3]. Brain disorders, including both mental and neurologic disorders account for one-third of the economic cost of all diseases[4].

Drinking plenty of water is publicly believed to be useful for health and has been recommended in various dietary guidelines. Findings from a systematic review revealed that increased water consumption had a weight-reduction effect[5], and it has widely been known as an approach in weight-loss programs[6]. In addition, several studies have reported a bidirectional link between excess body weight[7,8] or diabetes[9] and mental disorders. It has been indicated that pathogenic substrates are the same in both metabolic and brain disorders; and therefore, the term of "metabolic-mood syndrome" has been suggested[10]. Lifestyle changes may to some extent explain the concurrency of obesity and mental disorders. Replacing water with sugar sweetened beverages might be the reason for inverse link between water consumption and obesity[11,12]. There is also evidence indicating the higher risk for mental disorders especially depression with higher consumption of sugar sweetened beverages[13], as well as higher glycaemic index diets[14,15].

Overall, accumulating evidence suggests that the beneficial relation between water ingestion and mental disorders is possible. However, the knowledge regarding beneficial effects of water consumption in mental health is rare. Water facilitates signaling pathway and nutrients delivery to the brain, removes toxins and inflammatory markers and provides energy sources for brain, and thereby improves brain function. Although several studies have shown that water insecurity is associated with psychological distress and anxiety[16,17], to the best of our knowledge, there is no study assessing the association between the water quantity and common

Fax: +98-313-7923232

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Abstract

AIM

To investigate the relation between plain water drinking and risk of depression and anxiety among a large sample of Iranian adults.

METHODS

A total of 3327 Iranian general adults were included in this cross-sectional study. Validated Iranian version of the Hospital Anxiety and Depression Scale was used to assess anxiety and depression. Water consumption was assessed by asking about the number of glasses of water that consumed daily. Water consumption was categorized into < 2, 2-5, and ≥ 5 glasses of water/d.

RESULTS

In the crude model, the lowest level of water drinking (< 2 glasses/d) compared with reference group (≥ 5 glasses/d) doubled the risk of depression and anxiety (P < 0.0001). After adjusting potential confounders, this inverse link remained significant for depression (OR: 1.79; 95%CI: 1.32, 2.42; P < 0.0001), but not for anxiety (OR: 1.49; 95%CI: 0.98, 2.25; P = 0.109). In stratified analyses by sex, after controlling for potential confounders, water drinking < 2 glasses/d was associated with 73% and 54% increment in the risk of depression in men and women, respectively (P < 0.05), whilst no significant association was observed for anxiety either in men or in women.

CONCLUSION

We found inverse associations between plain water consumption and anxiety. Also, these findings showed a tended risky association, but not statistically significant, between lower levels of water consumption and anxiety. These findings warrant evaluation in prospective and clinical trials studies to establish the plausible role of water in mental health status.

Key words: Water; Anxiety; Depression; Psychological disorders; Iranian

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mental disorders including depression and anxiety. In the current study, therefore, we aimed to evaluate whether decreased plain water intake is associated with higher risk of mental disorders and whether it is gender-specific.

**MATERIALS AND METHODS**

**Subjects**
This cross-sectional study was carried out within the framework of the cross-sectional study on the Epidemiology of psychological, Alimentary health and Nutrition (SEPAHAN) project. The main aim of this project was to investigate the relationship between functional gastrointestinal disorders and lifestyle, nutritional factors and psychological profiles. The details of the project have been provided in Alibi et al. (2012). Briefly, the participants of the study were selected using multistage cluster and convenience sampling method amongst non-academic Isfahanian adults working at Isfahan University of Medical Sciences (IUMS) in 20 cities across Isfahan province. Each city was considered as a first stage’s cluster and health centers affiliated to IUMS in each city were considered as second stage clusters and among them, considering the full coverage of geographic regions, some centers were selected randomly and those participants who were willing to participate in SEPAHAN study were recruited. In order to increase the participation rate and the data collection accuracy, the project was conducted in two phases. In the first phase, 10087 questionnaires were distributed to the participants, collecting information about anthropometric measures, demographic profile, lifestyle, nutritional factors and physical activity. 8691 completed questionnaires were returned in the first phase (response rate: 86.16%). In the second phase, psychological data were collected (response rate: 64.6%). Finally, after matching returned questionnaires in phase 2 with their equivalents in phase 1, we reached 4763 questionnaires. Of these, 2904 persons had complete information about both water consumption and psychological profile which were included in the statistical analysis. The study protocol was reviewed and approved by the ethical committee of Isfahan University of Medical Sciences.

Water consumption was assessed by asking about the average number of glasses of plain water that usually consumed in a day by each participant. The possible items to answer were < 2 glasses/d, 2-5 glasses/d and ≥ 5 glasses/d.

**Mental disorders assessment**
A validated Iranian version of the Hospital Anxiety and Depression scale (HADS) was used to assess anxiety and depression[20]. HADS is a simple psychological questionnaire includes two separate parts to screen the severity of anxiety and depression. Each part includes 7 questions with a four-point rating scale (0-3); higher scores indicate greater degree of anxiety or depression. For both disorders, the score range is from 0 to 21. To identify the presence of either disorder, score 8 was considered as the cut point. Therefore, score 8 or greater were considered to have depression or anxiety and scores ≤ 7 were considered normal[26].

**Covariates assessment**
Dietary intakes of participants were assessed using a valid and reliable 106-item dish-based food frequency questionnaire[21]. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m²). The current level of participants’ physical activity was assessed using General Practice Physical Activity Questionnaire[22] and participants were categorized as physically moderately active, active, moderately inactive and inactive. Because of close relation between gastrointestinal disorders and psychological health, we considered functional gastrointestinal disorders (FGID) as an important covariate in our analysis. Suffering from gastrointestinal disorders was assessed using a valid and modified Iranian version of ROME III questionnaire[23]. FGID was defined as suffering from at least one of the following main gastrointestinal disorders: gastroesophageal reflux, dyspepsia, irritable bowel syndrome and constipation.

**Statistical analysis**
General characteristics in categories of plain water intake were reported as means and standard error (SE) or percentage for continuous variables and categorical variables, respectively. To examine the differences across plain water categories, analysis of variance (ANOVA) for continuous variables and χ² test for categorical variables were used. All dietary intakes were adjusted for age (yr) and weight (kg) by analysis of covariance (ANCOVA). Multiple logistic regression was used to estimate odds ratios (OR) (95%CI) for the presence of depression and anxiety across categories of plain water intake in crude and multivariable-adjusted models. In adjusted models, we controlled confounding impacts of age, sex, marital status (married, single, divorced, widowed), educational level (less than 12 years, 12-16 years and more than 16 years), BMI (continuous), smoking (non-and ex-smokers vs. current smokers), physical activity (moderately active and active vs. moderately inactive and inactive), FGIDs (Yes/No), intake of anti-psychotic medicines (Yes/No), and dietary intakes which play role in mental health [magnesium, riboflavin, pyridoxine, folate, cobalamin, Docosahexaenoic acid (DHA), Eicosa pentaenoic acid (EPA), energy, fibre and caffeine]. All confounders, including energy intake, were included in the statistical analysis as covariates. We performed stratified analyses, applying the above-mentioned models, by sex to evaluate potential modifying effect of sex related to mental health status. The adjusted models were also controlled for the same potential confounders, mentioned above. In all logistic regression analyses, P for linear trends was determined by Mantel-Haenszel.
extension chi-square test. All statistical analyses were done using Statistical Package for Social Sciences (SPSS, Inc., Chicago IL, United States; version 20). P < 0.05 was considered significant in all statistical analyses.

RESULTS

In terms of water intake, participants were categorized into three major classes (< 2 glasses, 2-5 glasses, ≥ 5 glasses/d). Those consumed more water had higher BMI (P < 0.0001) and were more probably to be younger, male, physically active (all P < 0.0001) and single (P < 0.05), but less educated compared with those who consumed less water (P = 0.005). Greater plain water drinking was associated with lower prevalence of smoking, anxiety, depression (P < 0.0001). Consistently, those consumed greater plain water had lower anxiety and depression score compared with those in the lowest category of plain water intake (< 2 glasses/d) (P < 0.0001). Water consumption was strongly associated with increased risk of FGID (P < 0.0001) (Table 1). Greater plain water consumption was associated with higher intakes of energy, protein, fat, carbohydrate, fibre, magnesium, riboflavin, pyridoxine, cobalamin, docosahexaenoic acid (DHA), eicosapentaenoic acid (EPA), fruits, vegetables and red meat (P for all <

| Variables                               | < 2 glasses/d | 2-5 glasses/d | ≥ 5 glasses/d | P value* |
|-----------------------------------------|---------------|---------------|---------------|----------|
| Participants (n)                        | 854           | 1764          | 769           |          |
| Age (yr)                                |               |               |               |          |
| BMI (kg/m²)                             | 37.2 ± 0.3    | 36.1 ± 0.2    | 34.8 ± 0.3    | < 0.0001 |
| Anxiety score²                         | 4.0 ± 0.1     | 3.5 ± 0.1     | 3.0 ± 0.1     | < 0.0001 |
| Depression score³ n (%)                 | 6.8 ± 0.1     | 6.1 ± 0.09    | 5.3 ± 0.1     | < 0.0001 |
| Anti-psychotic medicines use            | 303 (36.0)    | 478 (27.7)    | 151 (21.6)    | < 0.0001 |
| Currently smokers                      | 124 (14.2)    | 243 (13.8)    | 70 (9.9)      | < 0.0001 |
| Anxious                                | 303 (39.6)    | 729 (45.7)    | 350 (56.1)    | < 0.0001 |
| Marital status                          |               |               |               | 0.035    |
| Married                                 | 680 (81.4)    | 1431 (82.9)   | 549 (78.8)    |          |
| Single                                  | 135 (16.2)    | 271 (15.7)    | 139 (19.9)    |          |
| Other                                   | 20 (2.4)      | 25 (1.4)      | 9 (1.3)       |          |
| Fat (%)                                 |               |               |               |          |
| Carbohydrate (g/d)                     | 285.3 ± 4.2   | 294.5 ± 2.9   | 306.3 ± 4.9   | 0.006    |
| Fibre (g/d)                             | 22.0 ± 0.2    | 22.5 ± 0.1    | 23.0 ± 0.2    | 0.003    |
| Caffeine (mg/d)                         | 106.7 ± 3.1   | 96.7 ± 2.7    | 96.0 ± 2.7    | 0.022    |
| Magnesium (mg/d)                        | 314.1 ± 4.3   | 327.2 ± 3.0   | 349.6 ± 5.0   | < 0.0001 |
| Thiamin (mg/d)                          | 1.8 ± 0.03    | 1.8 ± 0.02    | 1.9 ± 0.03    | 0.062    |
| Riboflavin (mg/d)                       | 1.8 ± 0.03    | 1.9 ± 0.02    | 2.0 ± 0.03    | < 0.0001 |
| Pyridoxine (mg/d)                       | 1.9 ± 0.03    | 2.0 ± 0.02    | 2.1 ± 0.03    | < 0.0001 |
| Folate (mg/d)                           | 562.4 ± 5.8   | 573.8 ± 4.0   | 600.2 ± 6.7   | 0.801    |
| Cobalamin (mg/d)                        | 2.8 ± 0.05    | 3.0 ± 0.03    | 3.1 ± 0.05    | < 0.0001 |
| DHA (g/d)                               | 0.2 ± 0.01    | 0.2 ± 0.01    | 0.2 ± 0.01    | < 0.0001 |
| EPA (g/d)                               | 0.06 ± 0.003  | 0.1 ± 0.002   | 0.1 ± 0.003   | < 0.0001 |
| Food groups                             |               |               |               |          |
| Fruits (g/d)                            | 285.8 ± 8.7   | 322.4 ± 6.0   | 351.1 ± 10.1  | < 0.0001 |
| Vegetables (g/d)                        | 215.4 ± 4.8   | 241.4 ± 3.3   | 264.7 ± 5.5   | < 0.0001 |
| Nuts, legumes and soy (g/d)             | 55.5 ± 1.5    | 56.8 ± 1.0    | 60.9 ± 1.7    | 0.047    |
| White meat (g/d)                        | 59.4 ± 1.8    | 64.03 ± 1.2   | 67.5 ± 2.02   | 0.009    |
| Red meat (g/d)                          | 75.4 ± 1.8    | 78.4 ± 1.2    | 84.5 ± 2.06   | 0.004    |
| Refined grains (g/d)                    | 401.6 ± 7.1   | 390.7 ± 5.4   | 389.4 ± 9.11  | 0.473    |
| Whole grains (g/d)                      | 39.5 ± 2.9    | 40.8 ± 1.1    | 52.1 ± 3.40   | 0.007    |

1 Derived from one way ANOVA and chi-square test for continuous and categorical variables, respectively and analysis of covariance (ANCOVA) for nutrients and food groups; 2 Values are means ± SEs; 3 FGID defined as suffering from at least one of the following gastrointestinal disorders: Gastroesophageal Reflux, dyspepsia, irritable bowel syndrome and constipation; 4 The nutrients were adjusted for age and body weight. DHA: Docosahexaenoic acid; EPA: Eicosapentaenoic acid.
0.01). Tiamin, folate, white meat, refined grains, whole grains, nuts, legumes and soy consumptions were not significantly different across the categories of plain water intake.

Table 2 presents the general characteristics of study population stratified by the status of anxiety or depression. Individuals, who were anxious, but not depressed, were younger than healthy subjects. The prevalence of both depression and anxiety was higher among women, anti-psychotic medicines users, smokers and individuals who suffered from FGID. Conversely, healthy subjects were more probably to be physically active or moderately active, have higher education levels and drink more glasses of water. Whilst depression was less prevalent among married individuals, anxiety was more prevalent.

Crude and multivariable-adjusted ORs (95%CIs) of depression and anxiety across the categories of plain water intake are illustrated in Table 3. Compared with the reference group (≥ 5 glasses/d), lower levels of water consumption (< 2 glasses/d) was associated with a greater chance of having depression either in men or in women not only in crude but also in fully adjusted models (2-5 glasses/d: OR: 1.54; 95%CI: 1.00, 2.36 and < 2 glasses/d: OR: 1.73; 95%CI: 1.02, 2.93; P = 0.04) for men and in women (2-5 glasses/d: OR: 1.18; 95%CI: 0.86, 1.63 and < 2 glasses/d: OR: 1.54; 95%CI: 1.09, 2.15; P = 0.007). In the crude model drinking lower levels of water was associated with increased risk of anxiety in men (2-5 glasses/d: OR: 2.01; 95%CI: 1.20, 3.34 and < 2 glasses/d: OR: 1.83; 95%CI: 0.97, 3.43; P = 0.041) and in women (2-5 glasses/d: OR: 1.42; 95%CI: 0.98, 2.05 and < 2 glasses/d: OR: 1.59; 95%CI: 1.08, 2.34; P = 0.026); nevertheless, after adjustment for various confounders the significance associations disappeared in both genders.

### DISCUSSION

In this analysis of a large cross-sectional study of general adults, lower daily plain water intake was associated with increased risk of depression and anxiety in the crude model. Although controlling for potential confounders attenuated these associations, the inverse link for depression remained strongly significant, whilst anxiety risk tended to be higher for lower water intake in the final model.

To our knowledge, this was the first investigation to examine the association of plain water consumption and common mental disorders, although the linkage of water/fluid consumption with obesity[6,12,24], coronary diseases[25], hyperglycaemia or diabetes[26,27], cancer[28] and mortality[29,30] has been examined in earlier studies. Some of these studies[6,12,24,25], but not all[26-28], confirm
the beneficial effects of water drinking in reducing diseases’ risk. Therefore, due to bidirectional link between metabolic status and mental health\textsuperscript{[10]}, it might be concluded that water consumption can affect mental disorders risk via affecting metabolic status.

The bidirectional link between obesity and mental disorders is based on some shared peripheral and central pathological pathways, as well as genetic and environmental risk factors\textsuperscript{[10]}. However, in line with some studies\textsuperscript{[31,34]} we found that higher water consumption was associated with greater BMI. Therefore, some other plausible mechanisms may explain this inverse link. Our results indicate that higher water intake is associated with various healthy behaviours such as being more physically active and consuming greater amounts of nutrients particularly those involved in the nervous system (e.g., riboflavin, magnesium, pyridoxine and cobalamin), which is consistent with previous studies\textsuperscript{[31,34]}. Beneficial effects of these nutrients in neurotransmitters synthesis and transportation, as well as activity of many enzymes in the nervous system have been shown earlier\textsuperscript{[35,36]}. Nevertheless, even after controlling for dietary intakes, depression was significantly related to water consumption, and anxiety tended to be higher in those who drank less water. A possible reason for the inverse link between water consumption and the risk of depression might be the decreased activity of the sympathetic nervous system by drinking water which reduces plasma levels of norepinephrine\textsuperscript{[37]}. Elevated level of norepinephrine is a characteristic of psychosomatic depression\textsuperscript{[38]} which may induce noradrenergic-vasopressinergic activation.

Table 3. Multivariable-adjusted ORs (and 95%CIs) for depression and anxiety across categories of plain water consumption in the whole population and stratified by sex

|                      | Plain water drinking |                      |                          |                      |
|----------------------|----------------------|----------------------|--------------------------|----------------------|
|                      |                      | < 2 glasses/d        | 2-5 glasses/d            | ≥ 5 glasses/d        |<0.0001                  |
| Depression           |                      |                      |                          |                      |
| Crude model          | 2.04 (1.62, 2.56)    | 1.39 (1.13, 1.71)    | 1 (reference)            |                      |
| Model 1\textsuperscript{1} | 1.75 (1.35, 2.26)    | 1.30 (1.02, 1.64)    | 1 (reference)            |<0.0001               |
| Model 2\textsuperscript{1} | 1.84 (1.37, 2.45)    | 1.39 (1.07, 1.80)    | 1 (reference)            |<0.0001               |
| Model 3\textsuperscript{1} | 1.84 (1.40, 2.49)    | 1.41 (1.07, 1.84)    | 1 (reference)            |<0.0001               |
| Model 4\textsuperscript{1} | 1.79 (1.32, 2.42)    | 1.37 (1.04, 1.80)    | 1 (reference)            |<0.0001               |
| Anxiety              |                      |                      |                          |                      |
| Crude model          | 2.02 (1.46, 2.78)    | 1.73 (1.29, 2.32)    | 1 (reference)            |<0.0001               |
| Model 1\textsuperscript{1} | 1.53 (1.07, 2.17)    | 1.44 (1.04, 1.99)    | 1 (reference)            |0.026                 |
| Model 2\textsuperscript{1} | 1.58 (1.06, 2.36)    | 1.60 (1.11, 2.30)    | 1 (reference)            |0.029                 |
| Model 3\textsuperscript{1} | 1.56 (1.03, 2.35)    | 1.63 (1.12, 2.40)    | 1 (reference)            |0.066                 |
| Model 4\textsuperscript{1} | 1.49 (0.98, 2.25)    | 1.58 (1.08, 2.30)    | 1 (reference)            |0.109                 |
| Men (n = 1386)       |                      |                      |                          |                      |
| Depression           |                      |                      |                          |                      |
| Crude model          | 1.77 (1.19, 2.63)    | 1.37 (0.99, 1.90)    | 1 (reference)            |0.004                 |
| Model 1\textsuperscript{1} | 2.00 (1.26, 3.20)    | 1.45 (0.98, 2.13)    | 1 (reference)            |0.003                 |
| Model 2\textsuperscript{1} | 1.95 (1.18, 3.21)    | 1.59 (1.06, 2.38)    | 1 (reference)            |0.008                 |
| Model 3\textsuperscript{1} | 1.73 (1.02, 2.92)    | 1.54 (1.01, 2.36)    | 1 (reference)            |0.037                 |
| Model 4\textsuperscript{1} | 1.73 (1.02, 2.93)    | 1.54 (1.00, 2.36)    | 1 (reference)            |0.040                 |
| Anxiety              |                      |                      |                          |                      |
| Crude model          | 1.83 (0.97, 3.43)    | 2.01 (1.20, 3.34)    | 1 (reference)            |0.041                 |
| Model 1\textsuperscript{1} | 2.36 (1.17, 4.74)    | 1.55 (0.87, 2.78)    | 1 (reference)            |0.016                 |
| Model 2\textsuperscript{1} | 2.15 (1.02, 4.54)    | 1.59 (0.86, 2.95)    | 1 (reference)            |0.042                 |
| Model 3\textsuperscript{1} | 1.76 (0.81, 3.84)    | 1.55 (0.82, 2.94)    | 1 (reference)            |0.147                 |
| Model 4\textsuperscript{1} | 1.74 (0.80, 3.80)    | 1.52 (0.80, 2.88)    | 1 (reference)            |0.161                 |
| Women (n = 1941)     |                      |                      |                          |                      |
| Depression           |                      |                      |                          |                      |
| Crude model          | 1.75 (1.30, 2.35)    | 1.26 (0.95, 1.67)    | 1 (reference)            |<0.0001               |
| Model 1\textsuperscript{1} | 1.61 (1.17, 2.21)    | 1.21 (0.90, 1.63)    | 1 (reference)            |0.001                 |
| Model 2\textsuperscript{1} | 1.61 (1.16, 2.23)    | 1.21 (0.89, 1.65)    | 1 (reference)            |0.002                 |
| Model 3\textsuperscript{1} | 1.61 (1.15, 2.26)    | 1.22 (0.89, 1.67)    | 1 (reference)            |0.003                 |
| Model 4\textsuperscript{1} | 1.54 (1.09, 2.15)    | 1.18 (0.86, 1.63)    | 1 (reference)            |0.007                 |
| Anxiety              |                      |                      |                          |                      |
| Crude model          | 1.59 (1.08, 2.34)    | 1.42 (0.98, 2.05)    | 1 (reference)            |0.026                 |
| Model 1\textsuperscript{1} | 1.35 (0.89, 2.05)    | 1.41 (0.95, 2.07)    | 1 (reference)            |0.264                 |
| Model 2\textsuperscript{1} | 1.39 (0.91, 2.13)    | 1.44 (0.97, 2.15)    | 1 (reference)            |0.233                 |
| Model 3\textsuperscript{1} | 1.37 (0.88, 2.13)    | 1.44 (0.95, 2.18)    | 1 (reference)            |0.288                 |
| Model 4\textsuperscript{1} | 1.30 (0.83, 2.02)    | 1.40 (0.92, 2.12)    | 1 (reference)            |0.420                 

\textsuperscript{1}Derived from a Mantel-Haenszel extension chi-square test; \textsuperscript{2}Model 1: Adjusted for age, sex (in the whole population), marital status, educational level, model 2: Further adjustment for BMI, smoking, physical activity, model 3: Additional control for functional gastrointestinal disorders (FGID) and anti-psychotic medicines, model 4: Further control for magnesium, riboflavin, pyridoxine, folate, cobalamin, DHA and EPA, energy, fibre and caffeine. DHA: Docosahexaenoic acid, EPA: Eicosa pentaenoic acid.
and consequently the activation of the hypothalamic-pituitary-adrenal (HPA) axis. Increased vasopressinergic activation of the HPA axis has been suggested as a plausible mechanism in all depressive disorders\(^\text{[38]}\), which can be involved in mental symptoms production. In spite of similar link between water drinking and depression risk in men and women, the linkage for anxiety was stronger in men than women, though adjustment for antipsychotic medicines and FGIDs eliminated it. This difference between men and women might be related to sex-differences in the use of coping strategies\(^\text{[39]}\). However, the reasons for this difference are not clear and require further investigation.

In the current analysis, water consumption was evaluated using a direct question regarding the average amount of daily consumption of water, and data regarding other beverages intake and moisture contents of food were not considered. In addition, we provided predefined categories of plain water intake for participants. These factors may lead to misclassification of participants and decrease the reliability of our findings. However, it should be taken into account that noncalorically sweetened beverages are not public among Iranians and they are not used generally. Moreover, tea and coffee are mostly consumed with sugar. Therefore, since all other beverages, which consumed by this population, had calorie and we controlled the confounding effect of energy in our analysis, it could be concluded that our findings have enough precise. The consistence between our study’s results and available evidence regarding the health beneficial of water intake might be further reason to confirm the accuracy of our findings.

The limitations of the current study are using self-administered questionnaires for evaluating the study variables. However, the validity of all used instruments has been approved among Iranians. Although using self-reported tools of habitual fluid/water intake is a common limitation in this area of research, the validity of self-reported measures has been approved in earlier studies\(^\text{[40,41]}\). In addition, no ideal method has been determined to assess beverage consumption and applying 24-h recall or frequency questionnaire beside a computer program on food composition is the existing recommend method in this regard\(^\text{[42]}\). The cross-sectional design is another limitation that does not allow causal inferences. Indeed, it is possible that individuals with mental disorders tend to drink less water. Nevertheless, such changes would have weakened the associations identified. Therefore, the true estimates are probably even stronger than those we found. Moreover, since we studied the participants who are staffs of IUMS, although they were not academic and medical experts, this sample may not be representative of the entire general population and therefore the results of our study may not be generalizable to other individuals in our society. The strengths of this study are the large sample size and controlling various confounders’ effects.

In conclusion, we found inverse associations between plain water consumption and common psychological disorders. After controlling for various potential confounders, this association was stronger for depression, whilst for anxiety tended to be higher. These findings warrant evaluation in prospective studies to establish the plausible role of water in the mental health status.

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