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Evaluation of hydration status during the COVID-19 pandemic: a study of Turkish young adults

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ABSTRACT

Adequate hydration is an essential component of health at every stage of life. Although many factors such as age, gender, physical activity, drug use, and illness affect hydration status, it is vital to maintain water balance, especially in infectious diseases. This study was conducted to estimate the hydration status of young adults living in Turkey during the COVID-19 pandemic. The total water intake (TWI) and total water loss of the individuals were determined using the Water Balance Questionnaire (WBQ), which consists of questions about physical activity status, frequency of food and beverage consumption, water consumption, and water loss with urine and feces. The TWI of men and women was found to be 4,776.1 and 4,777.3 mL/day, respectively ($p > 0.05$). It was determined that 29% of the total water was obtained from drinking water, 49% from other beverages, and 22% from food. A positive net water balance was found in all body mass index (BMI) groups, men, and women. The net water balance was statistically lower in men (2,230.6 mL) than women (2,783.8 mL) ($p < 0.05$). As the COVID-19 pandemic continues, studies should be done on hydration status in the more balanced populations in terms of BMI and age groups.

Key words: COVID-19, hydration, water balance, water intake, WBQ

HIGHLIGHTS

- The present findings show that there is a positive net water balance in all body mass index groups, men and women.
- It was determined that 74.5% of men and 93.5% of women met the Dietary Reference Intake recommendation in terms of total water intake.
- Individuals' total energy intake (TEI) was found to be 2,538 kcal/day and the effect of energy taken from beverages on TEI was 7.6%.

INTRODUCTION

Water is the most vital nutrient and essential for all body functions, including regulation of body temperature, neural conduction, and many chemical reactions. Disturbances in hydration status cause changes in tissue osmolality and cell volume, leading to changes in cell and tissue function (Gibson & Maughan 2012). A continuous and adequate supply of water is essential to maintain an adequate state of hydration and support a healthy metabolism. Dehydration has been associated with a number of health disorders, including kidney dysfunction and cognitive impairment (Elmadfa & Meyer 2015). Also, it is assumed that low hydration status in the weeks prior to exposure to COVID-19 increases the risk of death from COVID-19 through multiple possible pathways that support fluid accumulation in the lungs (Stookey *et al.* 2020).

Drinking water and beverages like soft drinks, coffee, and tea are generally the main sources of water intake and about 65–80% of the total, as well as foods with high moisture content make a significant contribution. The metabolism of macronutrients for energy also provides water to the body. Water requirements depend on many factors such as environmental conditions, physical activity, nutrient composition of the diet (e.g. water content, electrolytes, nitrogen-containing substances, and dietary fiber), age, and gender (Elmadfa & Meyer 2015; Gandy *et al.* 2016). Water loss mainly consists of urine, respiratory water, feces, and sweat. Since the contribution of sweat to water loss is higher in a physically active person and in hot

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weather, it is affected by physical activity levels and season. Therefore, even in healthy individuals, water loss is highly variable depending on the individual's lifestyle and environmental conditions or geographic location (Malisova *et al.* 2016).

Dietary Reference Intake (DRI) for water is 3.7 L for men and 2.7 L for women (Campbell 2004). European Food Safety Authority in Europe (EFSA) recommends water intake for men 2.5 L and for women 2.0 L (IOM 2005; EFSA 2010). The fluid requirement for adults can generally met with volumes of 30–40 mL/kg/day, or at 1–1.5 mL/kcal expended, too (RDA 1989). Data on hydration status in population groups in free-living conditions are scarce. This situation creates an information gap and therefore an obstacle to supporting initiatives to improve the hydration of the population. There is an urgent need to create databases on the estimation of fluid intake and hydration status in the population (Malisova *et al.* 2016).

This study was conducted to estimate the hydration status of young adults living in Turkey during the COVID-19 pandemic.

MATERIALS AND METHODS

This study was conducted with an online questionnaire between November 2020 and January 2021 in order to evaluate the hydration status of young adults during the COVID-19 pandemic process. Within the scope of the study, 773 individuals were reached and the data of 684 individuals who met the study criteria were analyzed. Ethical approval was obtained for the study by the Aydin Adnan Menderes University Faculty of Health Science Non-Invasive Ethics Committee (No. 2020/050).

Research design

In this cross-sectional and descriptive study, data were collected through an online questionnaire consisting of questions about hydration status. The survey was shared via social media (such as Instagram, WhatsApp, and Facebook) or e-mail that can be accessed from any device with an internet connection by creating a link. A total of 684 individuals (102 men and 582 women) were reached during the study period.

Data collection

Data collection was done through a structured questionnaire created on Google Forms, and individuals were informed that all data would be used for research purposes only. Individuals' responses are kept confidential according to Google's privacy policy. In study we used the Water Balance Questionnaire (WBQ), a self-administrated semi-quantified food frequency questionnaire especially designed and validated with urine hydration biomarkers (Malisova *et al.* 2012).

The validity and reliability in Turkish version of the WBQ was made by Sen (2020) which includes a total of seven episodes: (a) individual's sociodemographic characteristics, (b) lifestyle characteristics, (c) physical activity status, (d) food consumption frequency, (e) drinking water and beverage consumption, the frequency (f) of fluid elimination from the body, and (g) the trends in fluid intake. Water balance was calculated by subtracting the total amount of water loss from the body through sweat, defecation, and urine from the total amount of water intake into the body by consuming beverages, foods, and drinking water. To determine the amount of water intake into the body to foods and beverages through food and fluid consumption, frequency form was calculated with computer-assisted nutrition program developed for the Turkey Nutrition Information System (BeBiS 7.2). Using the International Physical Activity Questionnaire (IPAQ) to determine water loss due to sweating in the calculation of body water loss, individuals' time for high, moderate, light (walking) level physical activity level, and resting was questioned (Biernat *et al.* 2008). Also, the amount of water discharged from the body according to the daily urination frequency and the defecation frequency of the individuals were used for the calculation of the amount of water loss.

Body mass index (BMI) was calculated using the body weight (kg) and height (m) of the individuals (kg/m^2). World Health Organization's (WHO) classification was used in the assessment of BMI (WHO 2000). The normal range is 18.5–24.9 kg/m^2, overweight is 25–29.9 kg/m^2, and obesity is $\geq$30 kg/m^2. The total weekly activity was obtained from the sum of high, moderate, light (walking) physical activity, and resting, and was expressed in MET-min/week. Total physical activity was classified as below 600 MET-min/week as low, 600–3,000 MET-min/week as moderate, and over 3,000 MET-min/week as high activity (Biernat *et al.* 2008).

Statistical evaluation of data

The data obtained from the research were evaluated with the SPSS 22 version statistical package program. Mean $\pm$ standard deviation (SD) or mean $\pm$ standard error (SE) for normally distributed numerical variables and number (n) and percentage (%) values were calculated in the evaluation of qualitative data. To examine the relationship between continuous and two-group variables, t-test was used for normally distributed data and Mann–Whitney U test for non-normally distributed data. Differences between groups in categorical variables were controlled by Student's t-test and chi-square test. The one-sample

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t-test was used to compare the total daily water intake calculated on the WBQ of the individuals and the DRI recommendations. One-way ANOVA test for normally distributed data in data grouped more than two; Kruskal–Wallis test was used for non-normally distributed data. Correlations were evaluated using Pearson's correlation coefficient. Partial correlations between water intake, energy intake, and beverage consumption adjusted for age, gender, body weight, and physical activity were calculated. Statistical significance in the analyses was evaluated at the $p < 0.05$ and $p < 0.001$ levels.

RESULTS

The sociodemographic and lifestyle characteristics of the individuals included in the study are shown in Table 1. A total of 684 individuals, including 102 men (14.9%) and 582 women (85.1%), were included in the study. The mean age of individuals was 24.3 ± 7.08 years, and the mean BMI for women and men were 21.9 ± 3.91 and 25.6 ± 4.20 kg/m^2, respectively. While 65.9% of the individuals had normal body weight, 13.6% were underweight and 20.5% were overweight or obese. There was a significant difference between men and women in terms of BMI classification ($p < 0.05$). Most of the individuals (68.0%) were university students. Those who did not use any medication or food supplements (83.8%) and those without any disease (84.6%) were in the majority. Only 5.7% of the individuals were receiving dietician support. There was no difference between genders according to educational status, drug use, using of food supplements, and dietician support ($p > 0.05$). Only women with urinary tract infections were significantly more than men ($p < 0.05$).

Figure 1 shows the mean daily beverage consumption of individuals according to their physical activity status. Although water was the most consumed beverage in all groups, there was no significant difference between the groups ($p > 0.05$). Hot beverages were consumed the most after water. Although there was no significant difference between the groups, milk, buttermilk/kefir, and energy and sports, drink consumption was higher in individuals with high physical activity levels. In all groups, consumption of vegetables and fruit juices, energy and sports drinks, and alcoholic beverages were lower compared with other beverages.

Table 2 shows individuals' status of meeting the DRI water intake recommendations. Accordingly, it is seen that the mean total water intake (TWI) of men and women met the DRI recommendation. It was determined that 74.5% of men ($n = 76$) and 93.5% of women ($n = 544$) met the DRI recommendation.

The contribution of foods and beverages in detail to water intake (g/day) and energy intake (kcal/day) is presented in Table 3. The mean of all food and beverage intake was 6,478.1 g/day, while total food intake was 1,553.0 g/day, total beverage intake was 4,925.1 g/day. The mean energy intake was 2,538 kcal/day for the total sample, 2,652 kcal/day for men, and 2,518 kcal/day for women ($p < 0.05$). Also, the contribution of beverages to total energy intake (TEI) was 7.3% for men and 7.7% for women. Buttermilk/kefir contributed the most to energy among beverages. Only the contribution of food to energy was significantly different between men and women ($p < 0.05$). The mean TWI was 3,398.3 g/day for the total sample, 3,423.6 g/day for men, and 3,393.8 g/day for women ($p > 0.05$). Also, the contribution of beverages to TWI was 67.7% for men and 68.6% for women. While the contribution of all beverages to water intake was 2,327.2 g/day, this contribution was mostly from drinking water (1,378.9 g/day), hot beverages (637.5 g/day), and buttermilk/kefir (115.8 g/day).

The hydration status calculated with the WBQ according to gender is shown in Table 4. When the TWI and total water loss of the individuals were evaluated, a positive net water balance (2,701.3 mL) was found. The net water balance was statistically lower in men (2,230.6 mL) than women (2,783.8 mL) ($p < 0.05$). While there was no significant difference between men and women in terms of the amount of water from food and beverages and TWI, total water loss from the body and water loss with high and moderate physical activity were significantly higher in men than women ($p < 0.05$). On the other hand, loss of water with light physical activity and urine was significantly higher in women than men ($p < 0.05$).

The hydration status calculated with the WBQ according to BMI groups is shown in Table 5. While total water loss did not differ significantly between underweight, normal body weight, or overweight/obese individuals, TWI increased significantly as BMI increased ($p < 0.05$). A positive net water balance was found in all BMI groups. Although not statistically significant, as BMI increased, net water balance value increased. When water loss was examined according to physical activity status, there was no significant difference between the BMI groups water loss with high, moderate, and light physical activity, while water loss with resting decreased significantly as BMI increased ($p < 0.05$).

Correlations between water intake, energy intake, and beverage consumption are shown in Table 6. TWI was weak correlated with energy intake from beverages, energy intake from food, and TEI ($r = 0.268$, $r = 0.111$, $r = 0.188$, $p < 0.001$), while

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Table 1 | Sociodemographic and lifestyle characteristics of individuals according to gender

	Men ($n = 102$)	Women ($n = 582$)	Total ($n = 684$)	p
Age (year)	27.5 ± 10.16	23.7 ± 6.23	24.3 ± 7.08	<0.001*
Body weight (kg)	80.2 ± 14.01	58.8 ± 11.32	62.0 ± 14.01	
Height (cm)	177.0 ± 6.80	163.6 ± 6.05	165.6 ± 7.81	
BMI (kg/m^2)	25.6 ± 4.20	21.9 ± 3.91	22.5 ± 4.16	
Education status				0.912
Primary school	3 (2.9%)	8 (1.4%)	11 (1.6%)	
High school	4 (3.9%)	25 (4.3%)	29 (4.2%)	
Graduate	90 (88.2%)	534 (91.8%)	624 (91.2%)	
Postgraduate	5 (4.9%)	15 (2.6%)	20 (5.4%)	
Marital status				0.002*
Married	26 (25.5%)	75 (12.9%)	101 (14.8%)	
Single	76 (74.5%)	507 (87.1%)	583 (85.2%)	
Working status				<0.001*
Not working	1 (1.0%)	48 (8.2%)	49 (7.2%)	
Student	59 (57.8%)	406 (69.8%)	465 (68.0%)	
Worker/Employee	6 (5.9%)	21 (3.6%)	27 (3.9%)	
Self-employment	11 (10.8%)	23 (4.0%)	34 (5.0%)	
Public officer	23 (22.5%)	83 (14.3%)	106 (15.5%)	
Retired	2 (2.05%)	1 (0.2%)	3 (0.4%)	
BMI classification				<0.001*
Underweight	1 (1.0%)	92 (15.8%)	93 (13.6%)	
Normal weight	58 (56.9%)	393 (67.5%)	451 (65.9%)	
Overweight	35 (34.3%)	70 (12.0%)	105 (15.4%)	
Obese	8 (7.8%)	27 (4.6%)	35 (5.1%)	
Drug use				0.866
None	85 (83.3%)	488 (83.9%)	573 (83.8%)	
Laxative	1 (1.0%)	-	1 (0.1%)	
Diuretic	2 (2.0%)	3 (0.5%)	5 (0.7%)	
Other (allergy, diabetes etc.)	14 (13.7%)	91 (15.6%)	105 (15.4%)	
Use of food supplements				0.897
Yes	17 (16.7%)	94 (16.2%)	111 (16.2%)	
No	85 (83.3%)	488 (83.8%)	573 (83.8%)	
Presence of disease				
None	95 (93.1%)	484 (83.1%)	579 (84.6%)	
Diabetes	2 (2.0%)	7 (1.2%)	9 (0.8%)	0.536
Urinary tract infection	5 (4.9%)	91 (15.6%)	96 (14.0%)	0.004*
Kidney failure	–	–	–	
Dietician support				0.706
Yes	5 (4.9%)	34 (5.8%)	39 (5.7%)	
No	97 (95.1%)	548 (94.2%)	645 (94.3%)	

Values are expressed as means and standard deviation (mean ± SD) for continuous variables or as number and percentage (n (%)) for categorical variables.
BMI, body mass index.
*The t-test, one-way ANOVA test, and chi-square test were performed to evaluate differences by gender. Significance for variables is accepted as $p < 0.05$.

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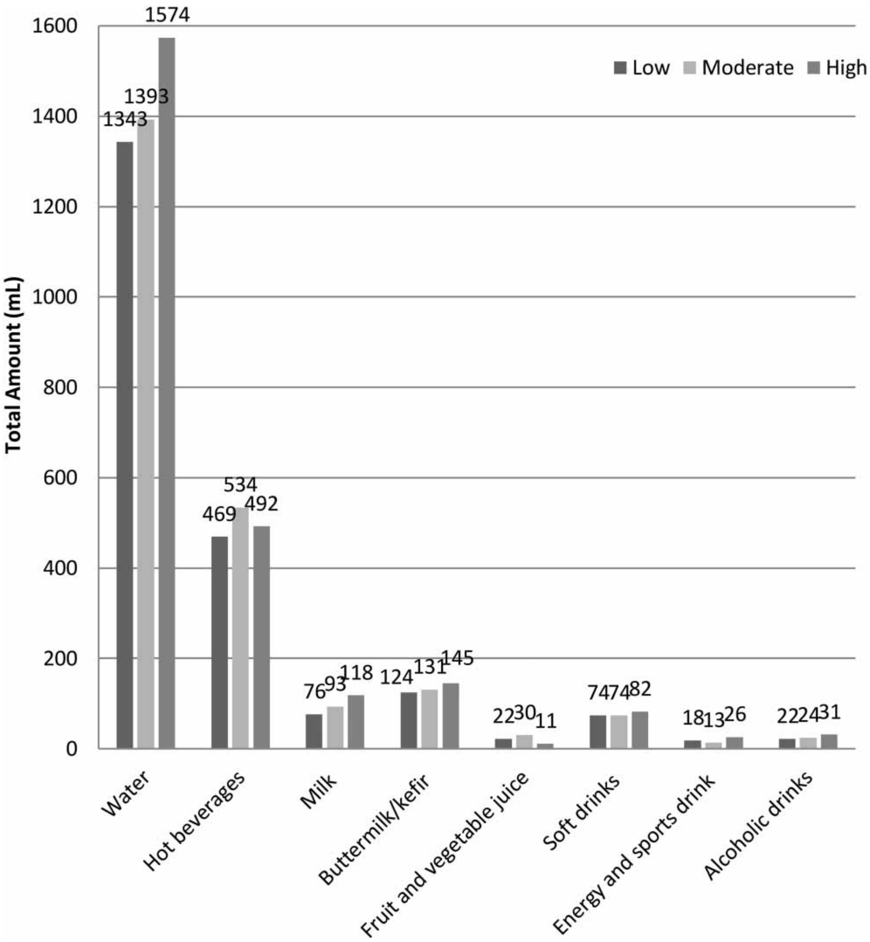

Figure 1 | Mean beverage consumption/day according to physical activity groups.

Table 2 | Comparison of the recommendations with the mean total water intake

	Total water intake	DRI recommendation	Difference[a] (95% confidence interval)
Men (mL/day)	4,776.1 ± 165.54	3,700	1,076.1 (747.72–1,404.49)
Women (mL/day)	4,777.3 ± 65.07	2,700	2,077.3 (1,949.49–2,205.10)

[a]One-sample *t*-test.

water intake from beverages was correlated moderately with energy intake from beverages ($r = 0.433$, $p < 0.001$). TWI from food showed strong correlation ($r = 0.618$, $p < 0.001$) with energy intake from food, while moderate correlation ($r = 0.599$, $p < 0.001$) with TEI. In addition, hot beverages, milk, and buttermilk/kefir had a moderate correlation with total water ($r = 0.353$, 0.205, and 0.225, respectively), and drinking water had a strong correlation ($r = 0.883$) with total water ($p < 0.001$).

DISCUSSION

Although many factors such as age, gender, physical activity, drug use, and illness affect hydration status, adequate hydration is an essential component of health at every stage of life. This study evaluated the hydration status of Turkish young adults in the COVID-19 pandemic using the WBQ, which includes physical activity status, food and beverage consumption frequency, water consumption, and water loss by urine and feces.

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Table 3 | Contribution of food and beverages to total water and energy intake of individuals using the WBQ ($n = 684$)

		Total weight consumed (g/day)				Contribution to energy intake (kcal/day)				Contribution to water intake (g/day)			
	Count	Men 102	Women 582	Total 684	p^1	Men 102	Women 582	Total 684	p^2	Men 102	Women 582	Total 684	p^3
All food and beverage	Mean (SE)	6,530.4 (207.87)	6,468.9 (88.78)	6,478.1 (81.60)	0.788	2,652 (53.62)	2,518 (23.54)	2,538 (21.63)	0.027*	3,423.6 (100.77)	3,393.8 (42.14)	3,398.3 (38.85)	0.785
Food only	Mean (SE)	1,611.4 (33.73)	1,542.8 (14.55)	1,553.0 (13.39)	0.068	2,459 (52.82)	2,323 (22.07)	2,344 (20.43)	0.018*	1,105.9 (25.85)	1,065.0 (11.04)	1,071.1 (10.16)	0.152
Beverages only	Mean (SE)	4,919.0 (206.62)	4,926.2 (87.39)	4,925.1 (80.43)	0.975	193 (15.19)	194 (7.43)	194 (6.71)	0.942	2,317.7 (97.62)	2,328.8 (40.61)	2,327.2 (37.47)	0.916
Hot beverages	Mean (SE)	526.4 (56.11)	503.4 (22.58)	506.8 (20.94)	0.695	3 (0.50)	3 (0.20)	3 (0.19)	0.919	642.7 (55.08)	636.5 (22.53)	637.5 (20.84)	0.916
Milk	Mean (SE)	83.8 (11.97)	87.9 (5.87)	87.3 (5.30)	0.782	59 (8.38)	62 (4.11)	61 (3.71)	0.782	75.4 (10.77)	79.1 (5.28)	78.6 (4.77)	0.782
Buttermilk/kefir	Mean (SE)	142.6 (20.91)	126.2 (7.41)	128.7 (7.03)	0.407	57 (8.36)	50 (2.96)	51 (2.81)	0.407	128.4 (18.82)	113.6 (6.67)	115.8 (6.33)	0.407
Fruit and vegetable juices	Mean (SE)	25.7 (3.88)	26.0 (3.07)	26.0 (2.67)	0.966	15 (2.33)	16 (1.84)	16 (1.60)	0.966	20.5 (3.10)	20.8 (2.45)	20.8 (2.14)	0.966
Soft drinks	Mean (SE)	23.1 (5.75)	18.0 (2.41)	18.8 (2.22)	0.412	15 (6.46)	12 (2.01)	13 (1.96)	0.690	18.7 (4.61)	14.3 (1.96)	15.0 (1.80)	0.384
Energy and sports drink	Mean (SE)	21.8 (7.14)	14.5 (3.98)	15.6 (3.55)	0.468	5 (1.61)	4 (1.01)	4 (0.90)	0.644	18.2 (6.02)	10.7 (2.89)	11.8 (2.62)	0.309
Alcohol	Mean (SE)	47.6 (11.18)	60.5 (7.12)	58.6 (6.29)	0.462	13 (2.82)	17 (1.74)	17 (1.54)	0.358	16.3 (4.12)	21.1 (2.72)	20.4 (2.39)	0.475
Water	Mean (SE)	1,352.5 (78.42)	1,383.5 (28.59)	1,378.9 (26.97)	0.683	–	–	–	–	1,352.5 (78.42)	1,383.5 (28.59)	1,378.9 (26.97)	0.683

Values are expressed as means and standard error (SE) for continuous variables.

WBQ, Water Balance Questionnaire; g, gram; kcal, kilocalories; p^1, significance between total weight consumed value in men and women; p^2, significance between contribution to energy intake in men and women; p^3, significance between contribution to water intake in men and women.

*Student's *t*-test was performed to evaluate differences by gender. Significance for variables is accepted as $p < 0.05$.

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Table 4 | Comparison of individuals by hydration status and gender ($n = 684$)

	Men ($n = 102$) Mean ± SE	**Women ($n = 582$) Mean ± SE**	**Total ($n = 684$) Mean ± SE**	***p***
Total water intake (mL)	4,776.1 ± 165.54	4,777.3 ± 65.07	4,777.1 ± 60.57	0.994
Total water from food (mL)	1,105.9 ± 25.85	1,065.0 ± 11.04	1,071.1 ± 10.16	0.152
Total water from beverages (mL)	2,317.7 ± 97.62	2,328.9 ± 40.62	2,327.2 ± 37.48	0.916
Water taken with drinking water (mL)	1,352.5 ± 78.42	1,383.5 ± 28.59	1,378.9 ± 26.97	0.683
Total water loss from the body (mL)	2,545.5 ± 250.04	1,993.5 ± 20.23	2,075.8 ± 41.61	<0.001*
Water loss by high physical activity (mL)	408.2 ± 71.24	78.0 ± 10.20	127.3 ± 14.41	<0.001*
Water loss by moderate physical activity (mL)	365.3 ± 235.47	47.3 ± 6.14	94.7 ± 5.62	<0.001*
Water loss by light physical activity (mL)	169.2 ± 17.90	194.7 ± 8.84	190.9 ± 7.98	0.225
Water loss by resting (mL)	0.1 ± 0.01	0.1 ± 0.00	0.1 ± 0.03	0.029*
Water loss in urine (mL)	1,467.1 ± 29.13	1,538.7 ± 13.19	1,528.0 ± 12.07	0.038*
Fecal water loss (mL)	135.8 ± 1.80	134.8 ± 0.76	135.0 ± 0.70	0.636
Net water balance (mL)	2,230.6 ± 3,081.60	2,783.8 ± 1,627.53	2,701.3 ± 1,922.61	0.007*

Values are expressed as means and standard error (mean ± SE) for continuous variables.
mL, milliliter.
*Student's *t*-test was performed to evaluate differences by gender. Significance for variables is accepted as $p < 0.05$.

Table 5 | Comparison of individuals by hydration status and BMI groups ($n = 684$)

	Underweight ($n = 93$) Mean ± SE	**Normal weight ($n = 451$) Mean ± SE**	**Overweight/obese ($n = 140$) Mean ± SE**	***p***
Total water intake (mL)	4,503.9 ± 146.47	4,791.2 ± 68.59	5,278.9 ± 229.57	0.042*
Total water from food (mL)	1,023.6 ± 24.95	1,076.5 ± 11.49	1,111.0 ± 39.67	0.136
Total water from beverages (mL)	2,203.3 ± 95.88	2,333.4 ± 42.02	2,557.9 ± 156.32	0.179
Water taken with drinking water (mL)	1,276.9 ± 60.22	1,381.4 ± 30.77	1,610.0 ± 107.80	0.057
Total water loss from the body (mL)	1,994.4 ± 52.24	2,097.3 ± 50.24	1,951.1 ± 65.73	0.550
Water loss by high physical activity (mL)	112.1 ± 34.63	134.5 ± 16.66	52.8 ± 25.77	0.423
Water loss by moderate physical activity (mL)	31.9 ± 10.28	107.7 ± 43.73	53.9 ± 30.67	0.742
Water loss by light physical activity (mL)	198.3 ± 21.34	187.5 ± 8.86	225.0 ± 36.00	0.550
Water loss by resting (mL)	0.1 ± 0.01	0.1 ± 0.00	0.1 ± 0.01	0.003*
Water loss in urine (mL)	1,517.7 ± 31.87	1,532.2 ± 13.59	1,488.3 ± 43.13	0.687
Fecal water loss (mL)	134.4 ± 1.94	134.3 ± 0.76	131.0 ± 3.45	0.380
Net water balance (mL)	2,509.5 ± 153.21	2,693.9 ± 85.22	3,327.8 ± 234.41	0.098

Values are expressed as means and standard error (mean ± SE) for continuous variables.
BMI, body mass index; mL, milliliter.
*One-way ANOVA and Kruskal–Wallis test were performed to evaluate differences by BMI. Significance for variables is accepted as $p < 0.05$.

Hydration reflects a balance between TWI and loss. TWI consists of water from a variety of sources, namely, drinking water, beverages, fluid, and solid foods. In most studies, water and beverages contribute approximately 80%, and solid and fluid foods approximately 20% to water intake (Bardosono *et al.* 2015; Malisova *et al.* 2016). In a cross-sectional nutrition study ($n = 1,386$), it was found that TWI was 2.2 L/day for men and 1.9 L/day for women, and 30% of the total water was supplied from drinking water, 37% from other beverages, and 33% from food (Ozen *et al.* 2018). The French National Nutrition and Health Survey ($n = 94,939$) was reported that TWI was 2.3 L/day for men, 2.1 L/day for women, 61.9% of the TWI was obtained from beverages, and 38.1% from food (Szabo de Edelenyi *et al.* 2016). In the study where the WBQ was developed, the TWI of the individuals was found to be 3,466 mL/day, the amount of water loss was 3,410 mL/day, the water

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Table 6 | Partial correlations between water intake, energy intake, and beverage consumption adjusted for age, gender, body weight, and physical activity using the WBQ

	Total water (from food and beverages) (g/day)	Total water from beverages (g/day)	Total water from food (g/day)	Total food weight (g/day)	Total beverages weight (g/day)	Total energy (kcal/day)	Total energy from food (kcal/day)	Total energy from beverages (kcal/day)
Total water (g/day) (from food and beverages)	1	0.935**	0.164**	0.159**	0.928**	0.188**	0.111**	0.268**
Total water (g/day) from beverages	0.935**	1	−0.001	−0.002	0.999**	0.136**	0.002	0.433**
Total water (g/day) from food	0.164**	−0.001	1	0.972**	−0.001	0.599**	0.618**	0.050
Total food weight (g/day)	0.159**	−0.002	0.972**	1	−0.002	0.745**	0.773**	0.048
Total beverages weight (g/day)	0.928**	0.999**	−0.001	−0.002	1	0.145**	0.001	0.464**
Total energy (kcal)	0.188*	0.136**	0.599**	0.745**	0.145**	1	0.951**	0.330**
Total energy (kcal) from food	0.111*	0.002	0.618**	0.773**	0.001	0.951**	1	0.020
Total energy (kcal) from beverages	0.268**	0.433**	0.050	0.048	0.464**	0.330**	0.020	1
Hot beverages (g/day)	0.353**	0.552**	−0.016	−0.017	0.553**	0.048	−0.033	0.253**
Milk (g/day)	0.205**	0.310**	0.023	0.024	0.328**	0.229**	0.026	0.657**
Buttermilk/kefir (g/day)	0.225**	0.366**	−0.017	−0.016	0.384**	0.177**	−0.013	0.609**
Fruit and vegetable juice (g/day)	−0.027	0.005	0.024	0.028	0.015	0.084*	0.010	0.239**
Soft drinks (g/day)	0.113**	0.212**	0.027	0.026	0.234**	0.198**	0.012	0.599**
Energy and sports drink (g/day)	0.119**	0.165**	0.039	0.028	0.174**	0.084*	0.002	0.266**
Alcoholic drinks (g/day)	−0.029	−0.020	0.011	0.012	−0.018	0.045	0.014	0.102**
Water (g/day)	0.883**	0.708**	−0.007	−0.004	0.695**	0.007	0.014	−0.020

WBQ, Water Balance Questionnaire; g, gram; kcal, kilocalories.
*Correlation is significant at the 0.05 level.
**Correlation is significant at the 0.001 level.

balance was 27 mL/day, and found that 50% of the TWI was from drinking water, 30% from other beverages, and 20% of them were obtained from food (Malisova *et al.* 2012). In another study by Malisova *et al.* (2013), the net water balance was found −63 mL/day, and the TWI was 2,892 mL/day in the Greek population. It has been reported that 50% of TWI comes from drinking water, 26% from other beverages, and 24% from food. In this study, it was determined that 29% of the total water was obtained from drinking water, 49% from other beverages, and 22% from food. When the TWI and total water loss of the individuals were evaluated, a positive net water balance was found. Individuals' TWI was found to be higher than other studies (Malisova *et al.* 2016; Mistura *et al.* 2016; Szabo de Edelenyi *et al.* 2016; Ozen *et al.* 2018), also it seemed to meet the recommendations. It is thought that this situation may be related to the pandemic as well as the diversity of the study groups, levels of education, eating habits, physical activity levels, and the health awareness of the population. In addition to the frequency of beverage consumption in our study, the determination of the amount of water in foods using the food frequency questionnaires instead of the 24-h food consumption record used in other studies may be another reason.

Available data on gender differences in hydrated status are insufficient and inconsistent. While there are studies showing that women are more vulnerable to insufficient fluid intake (Haveman-Nies *et al.* 1997; Ferry *et al.* 2001), recent studies show an increased risk of dehydration in men (Drywien & Galon 2016; Nissensohn *et al.* 2016). In our study, a positive net water balance was statistically lower in men than in women ($p < 0.05$). While there was no significant difference between men and women in terms of the mean TWI, the mean total water loss was significantly higher in men than in women ($p < 0.05$). In this case, a higher amount of water loss by high and moderate physical activity in men and a higher amount of water loss in urine in women were significantly effective. Considering the TWI of individuals, 74.5% of men and 93.5% of women met the DRI recommendations. Also, according to Turkey Nutrition and Health Survey (TBSA 2019) data, the mean daily water

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consumption of individuals was found to be 1,766.4 ± 1,039.56 mL for men and 1,423.8 ± 860.38 mL for women. In this study, the mean daily water consumption was found lower than the general Turkish population. This may be due to economic and health-related differences between the general population and young, healthy adults also may be related to individuals being less active due to the pandemic.

The water content in food, as well as drinking water and other beverages intake, may have a role in body weight homeostasis by affecting overall diet energy density. Recent data have shown that hydration status was associated with the energy density of the diet and dietary profile (Pérez-Escamilla *et al.* 2012; Rolls 2017). At the same time, it is known that factors such as water intake and hydration status are effective in weight regulation and obesity development (Ang *et al.* 2013; Riebls & Davy 2013; Hruby & Hu 2015). In the National Health and Nutrition Examination Survey (NHANES) study, which represented adults aged 18–64 years from 2009 to 2012, a significant association between higher BMI and inadequate hydration was reported (Chang *et al.* 2016). Similarly, another study using NHANES data showed that obese adults were more likely to have hypohydration, and the association between increased water intake and hypohydration was weaker in obese than adults with underweight or normal body weight (Rosinger *et al.* 2016). In a recent study, no significant relationship was found between individuals' hydration attitudes or water intake and BMI (Veilleux *et al.* 2019). In our study, the TWI of overweight/obese individuals was found to be significantly higher than individuals with underweight or normal body weighed ($p < 0.05$). Unlike previous studies, positive hydration was found in all BMI groups, and although not statistically significant, overweight/obese individuals had higher net water balance than other individuals. Although the number of overweight/obese adults is quite small, these results need to be confirmed in a population balanced in terms of BMI groups.

In this study, TWI was 4,777.1 mL/day and the most consumed drink was water, and its contribution to TWI was 40.6%. The contribution of water from beverages to TWI was 68.5%, and the contribution of water from food was 31.5%. Water intake from beverages was similar to the EFSA estimate (70–80% from beverages and 20–30% from food). In many studies, the contribution of beverages and foods to TWI was found to be similar (O'Connor *et al.* 2014; Nissensohn *et al.* 2016). In our study, hot beverages, buttermilk/kefir, and milk provided the greatest contribution to TWI after drinking water. Similarly, hot drinks such as tea and coffee were the most contributing drinks for Australian adults (Sui *et al.* 2016). The hot beverages (18.1%) made the most contribution of water from beverages in French adults, followed by alcoholic beverages, milk, and fruit/vegetable juices, respectively (Szabo de Edelenyi *et al.* 2016). The reason for the high contribution of hot beverages to TWI may be that the study was conducted during the winter months.

Many beverages contribute to the TEI. The mean energy contribution of beverages to TEI across European countries varies between 7 and 16% (Ozen *et al.* 2018). EFSA and WHO recommend that the energy from beverages should not exceed 10% (WHO 2003; EFSA 2010). In a study conducted with British adults, it was found that beverages accounted for about 16% of the TEI. Among these drinks, it was reported that alcoholic beverages made the most contribution (Gibson & Shirreffs 2013). In another study conducted with Italian adults, it was found that the energy from beverages contributed 6% to the TEI, and alcoholic beverages contributed the most (Mistura *et al.* 2016). In our study, the TEI was 2,538 kcal/day, and the effect of energy from beverages on TEI was found to be 7.6% similar to the study in Italy. The beverage that made the most contribution was milk (2.4%), similar to a study conducted in the Spanish population followed by buttermilk/kefir and fruit/vegetable juices (Ozen *et al.* 2018). Contrary to the studies conducted in many European countries (Gibson & Shirreffs 2013; Mistura *et al.* 2016; Szabo de Edelenyi *et al.* 2016; Ozen *et al.* 2018), the contribution of alcoholic beverages to the TEI in the Turkish population was very low. In our study, the contribution of beverages to TEI was found to be relatively low, and this may be due to the higher consumption of hot beverages with very low energy content, as shown in the study.

The main limitation of the present study is represented by a self-reported questionnaire, which may lead to the actual misreporting of data. Since retrospective food and beverage consumption frequency methods are based on individuals' memory and recall skills, it created difficulties in reflecting the estimation of actual consumption. In addition, a comprehensive evaluation was made with the WBQ to estimate the hydration status of individuals without the need for laboratory methods. The findings cannot be generalized for all age groups, as the study data mainly consist of young adults. However, this study is important for estimating the hydration status of young adults in Turkey during the COVID-19 pandemic. These data will be necessary in order to formulate public health recommendations.

In conclusion, our study gives an overview of the characteristics of the water intake of Turkish young adults. In all BMI groups, men and, women, a positive net water balance was found. As the COVID-19 pandemic continues, studies are needed on hydration status in the more balanced populations in terms of BMI and age groups. In addition, more research should be done to examine hydration status in different populations to determine the optimal water intake level.

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COMPETING INTEREST

The authors have no conflicts of interest to declare.

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DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

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