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Drinking water intake of adults in typical cities in the major river basins of China

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ABSTRACT

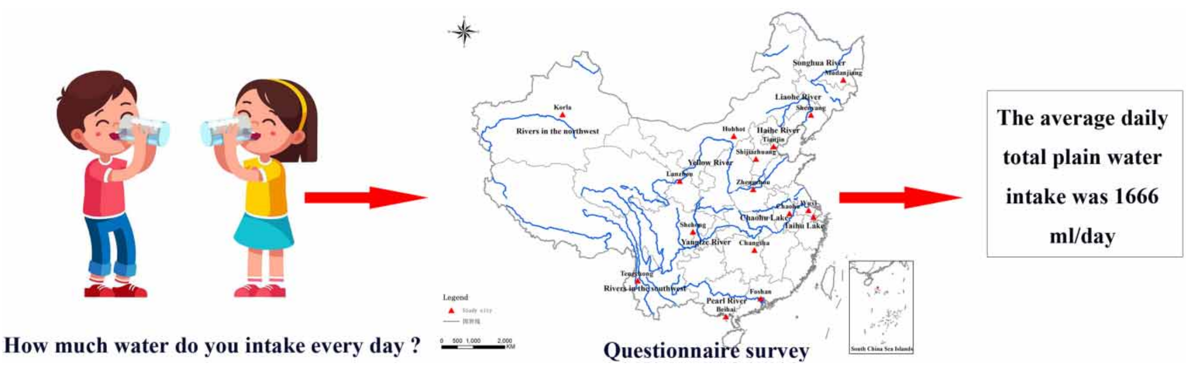
Water is indispensable to human life. Data on water consumption are essential for many health-related analyses. However, water consumption patterns vary significantly due to many factors, such as region, culture, and season. A survey was conducted on the drinking water intake of adults in typical cities in the major river basins of China. The intake rates of direct plain water, indirect plain water, commercial beverages, total plain water, and total water were assessed. The total plain water intake and total water intake were 1,777 and 1,942 ml/day for males, and 1,564 and 1,678 ml/day for females, respectively. Water intake varies depending on gender, age, body mass index, and seasonal and regional fluctuations. Region is the most important factor influencing the intake of total plain water, direct plain water, and total water, followed by season and gender. The intake of indirect plain water is mainly related to the region. Age is the most important factor affecting commercial beverage intake. A value of 1,666 ml/day is proposed as the recommended daily total plain water intake rate for use in exposure assessments in the Chinese context.

Key words: direct plain water, indirect plain water, total water, water intake rate

HIGHLIGHTS

- Drinking water intake levels among adults in major river basin cities in China were also assessed.
- The effects of sex, season, region, age, and body mass index on water consumption were explored.
- A recommended daily total plain water intake rate was provided for use in the exposure assessments.

GRAPHICAL ABSTRACT



1. INTRODUCTION

Water is necessary to sustain all forms of life, and humans can only live a few days without it (WHO 2022). Drinking water can prevent dehydration, which might lead to unclear thinking, mood alteration, overheating, constipation, and kidney stones (Popkin *et al.* 2010; Karger 2018). For sedentary adult men and women under average circumstances, 2,900 and 2,200 mL of water per day are regarded as necessary for hydration; and for physically active men, women, and children in high temperatures, 4,500 mL of water per day is required (WHO 2005). EFSA suggested that the adequate total water intake for females should be 2.0 L/day and for males 2.5 L/day (EFSA 2010). In the United States, the recommended daily intake of total water for females is 2.7 L and for males it is 3.7 L (Patel *et al.* 2020).

Water ingestion is a pathway of exposure to environmental chemicals (ATSDR 2023). People may be exposed to contaminants in water when consuming water directly as plain water, or indirectly from foods and drinks made with water (Babuji *et al.* 2023). Estimating the magnitude of the potential dose of toxins from water ingestion requires information on the quantity of water consumed. In addition, when setting up the drinking water quality standard, it is also necessary to deduce the standard limit according to the relevant drinking water intake parameters.

For risk assessment related to drinking water contamination, a default water ingestion value of 2 L/day per person is suggested by the United States, the World Health Organization, and other countries or agencies (USEPA 2018; WHO 2022). However, several factors may affect the amount of water consumed, such as temperature (seasonal and/or regional effects), the aesthetic quality of drinking water, cultural differences, as well as age, gender, physical activity, and diet (Roche *et al.* 2012; Malisova *et al.* 2013; Armstrong & Johnson 2018). Water intake can also be affected by dietary habits and cooking methods. Asian people consume rice and noodles as staple foods, which contain a greater proportion of water (60% of weight) compared with bread (30–40%) (Tani *et al.* 2015). In China, two large-scale studies have been conducted, focusing on the total fluid intake and types of fluids consumed in urban China by age, gender, region, and city socioeconomic status, while fluid intake from foods was not assessed (Ma *et al.* 2012; Zhang *et al.* 2018).

In this study, we conducted a survey to collect information on the drinking water consumption of residents in major cities of China's major river basins. The water intake level of Chinese adults was evaluated, and direct plain water, indirect plain water, commercial beverages, total plain water, and total water intake were provided, and the effects of gender, season, region, age, and body mass index on water intake were explored. A recommended daily water ingestion rate for use in exposure assessments was also provided.

2. MATERIALS AND METHODS

2.1. Study areas and population

Considering that the basin is a special type of region, whose components, including water quality and people's living habits, are closely related, 16 major cities (Mudanjiang, Shenyang, Tianjin, Shijiazhuang, Lanzhou, Zhengzhou, Hohhot, Changsha, Shehong, Chaohu, Wuxi, Pinghu, Foshan, Beihai, Tengchong, and Korla) in China's major river basins, including the Songhua River, Liaohe River, Haihe River, Yellow River, Yangtze River, Chaohu Lake, Tai Lake, Pearl River, rivers in the southwest, and rivers in the northwest of China, were selected as study areas using a multi-stage stratified cluster randomized sampling method. The map of the study areas is shown in Figure 1. Based on the water supply population of the chosen city, the total sample size and the sample size of each city are determined through Neyman allocation (Arnab 2017). In this study, the number of people surveyed in the same city should not exceed 600, and to guarantee the precision of the survey data, the minimum sample size of each city should not be less than 240. In each city, within the water supply scope of the selected water treatment plant, one township is randomly chosen in accordance with the east, south, west, north, and middle directions. Moreover, one administrative village is randomly selected from each township as the survey site. In case the water treatment plant covers fewer than 5 townships, all townships within the water supply area were included in the survey. Sampling within administrative villages adheres to the principle of randomness and random numbers were utilized for drawing according to the list of residents.

The participants are 18-year-olds and above adult residents recruited from the study areas until the quotas for age and gender in relation to the total country population are met.

2.2. Questionnaire survey

Before the formal questionnaire survey was carried out, we chose Chaohu City to conduct a preliminary survey. In accordance with the results of the survey, we evaluated the selection of residents, the content of questionnaires, and survey methods, to enhance the validity and reliability of the survey; then, optimized and rectified any deficiencies. The formal survey is conducted in summer and winter, respectively. The survey method adopts the combination of a direct face-to-face questionnaire survey and a self-filling log. Each survey lasts for 7 days. On the first day, the investigator entered the house and conducted a face-to-face questionnaire survey with the residents. The investigator filled in the questionnaire according to the residents' answers to the questionnaire and collected the questionnaire. At the same time, the investigator told the residents how to

Figure 1 | Map of study areas.

complete a self-filling log. From the second day to the seventh day, the respondents filled the self-filling log themselves, and all self-filling logs were collected and stored by the investigator. To guarantee the quality of the self-filling log, the investigators conducted telephone interviews with residents from the second day to the seventh day and provided answers to various questions when they were filling in the questionnaires.

The survey information on drinking water intake mainly includes drinking habits, frequency, and intake of direct plain water, indirect plain water, and commercial beverages. Direct plain water refers to plain water consumed directly as cold water (e.g. tap water, spring water, purified water, groundwater, and mineral water) and boiled water such as barley tea. Indirect plain water was intended to include the tap water added for preparation in foods such as soup, porridge, rice, steamed bread, and noodles. Commercial beverages include many kinds of drinks which can be purchased in the market, such as bottled tea or coffee, sports drinks, milk products, juices, carbonated soft drinks, and alcoholic beverages. In China, the majority of the coffee that people consume is purchased from merchants, and a few people prepare it themselves. Hence, coffee is categorized as a kind of commercial beverage. In addition to water and tea, bottled tea also contains white granulated sugar, citric acid, sodium citrate, D-sodium erythorbate, vitamin C, honey, and other ingredients. As a result, it is also considered a commercial beverage.

2.3. Calculation of water consumption

The intake of all types of water was averaged based on 7-day survey results. Total plain water intake is the amount of indirect plain and direct plain water. Total water intake is the amount of indirect plain water, direct plain water, and commercial beverages. For calculating the amount of indirect plain water intake for each individual per day through diet food consumption, representative water contents of the soup, porridge, rice, steamed bread, and noodles were summed. The water content of each dish was computed by multiplying the volume of daily food intake with the water content of the food. The proportion of water content used to calculate is 95, 85,70.1, 40.3, and 72.3% for the soup, porridge, rice, steamed bread, and noodles, respectively (Yang 2019).

2.4. Statistical analysis

All calculations and statistical procedures were performed using SPSS software version 18.0 for Windows (IBM SPSS Statistics, Chicago, IL, USA). Wilcoxon rank test was used to compare the means of water intake rate by gender, season, age groups, region, and BMI. Categorical regression analysis was performed to evaluate the impact of various influence factors on the water intake rate. All statistical tests were two-tailed and the significance level was set at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1. Sample description

The demographic characteristics of the participants are presented in Table 1. A total of 13,106 participants aged from 18 to ≥65 were included, with 6,741 in summer and 6,365 in winter. The proportions of different age groups (18–21, 25–34, 35–44, 45–54, 55–64, and ≥65) were 12, 19, 18, 17, 17, and 17%, respectively. The male-to-female ratio was 1.00:1.08.

3.2. Percentage of plain water by types

As shown in Figure 2, the main source of plain water for the surveyed population was tap water, which accounted for 68.53%. The second was bottled/barreled water and filtered water from household water purifiers, with 13.46 and 12.44%, respectively. In addition, filtered water from community water purifiers and well water were also sources of plain water, with an average percentage of 1.86 and 1.76%, respectively.

Some socio-demographic factors, particularly income, affect the priority of needs, higher income earners are more likely to pay to improve drinking water quality and use bottled/barreled water and water purifiers (Huang *et al.* 2015; Van Houtven *et al.* 2017). A study in Iran found that about 1.04 billion liters on average of bottled water was consumed annually between 2000 and 2015. Bottled water consumption increased from 0.41 to 48.9 L/capita-year (Aslani *et al.* 2021). In a survey of

Table 1 | Characteristics of study participants

	Gender		Season		Age (year)					
Region	Male	Female	Summer	Winter	18–24	25–34	35–44	45–54	55–64	≥ 65
Chaohu	304	332	316	320	78	115	128	132	97	86
Lanzhou	649	660	672	637	190	252	201	252	216	198
Foshan	520	504	519	505	161	178	162	175	184	164
Beihai	227	286	315	198	55	126	95	102	79	56
Shijiazhuang	174	173	176	171	57	67	62	58	51	52
Zhengzhou	614	665	673	606	188	249	209	214	205	214
Mudanjiang	593	699	681	611	33	252	189	204	317	297
Changsha	304	312	307	309	96	105	103	109	115	88
Wuxi	615	662	660	617	193	238	197	218	237	194
Shenyang	571	653	607	617	143	236	170	208	232	235
Hohhot	298	320	314	304	101	105	108	106	95	103
Shehong	291	297	304	284	23	89	98	136	92	150
Tianjin	593	640	621	612	120	197	385	178	168	185
Korla	178	238	208	208	21	114	96	128	27	30
Tengchong	161	170	165	166	31	51	66	60	67	56
Pinghu	198	205	203	200	22	63	76	103	77	62
Total	6,290	6,816	6,741	6,365	1,512	2,437	2,345	2,383	2,259	2,170

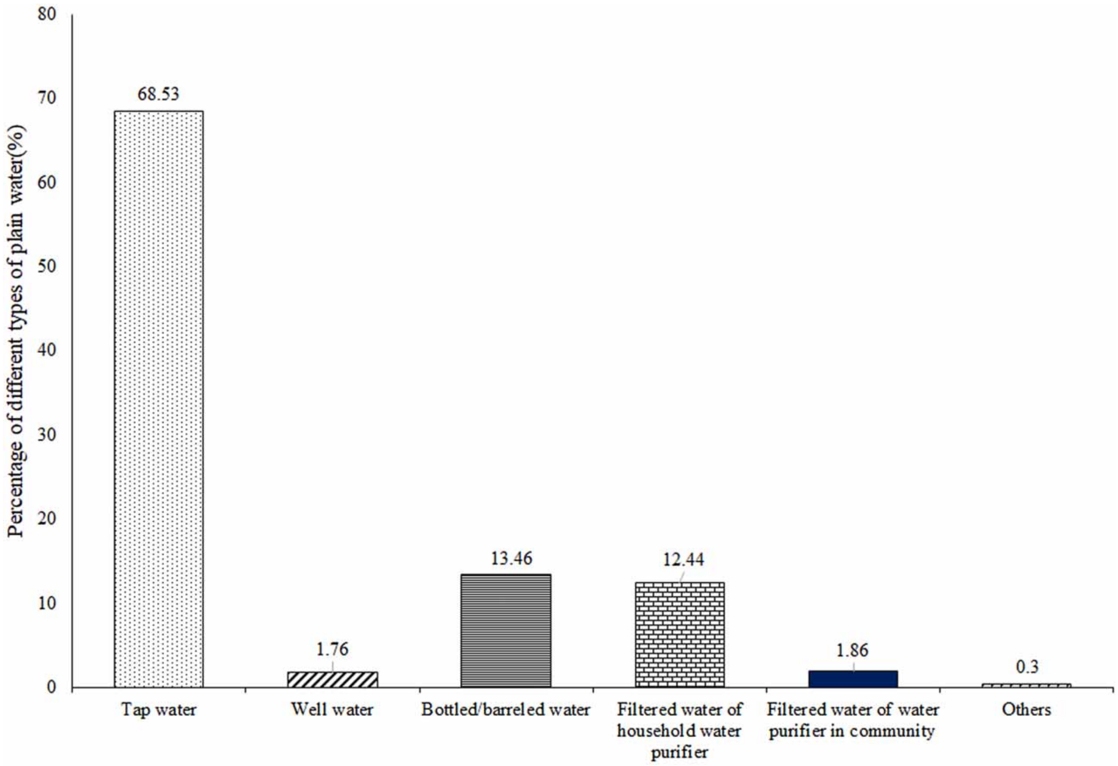


Figure 2 | Percentage of different types of plain water.

drinking water consumption patterns among private well users in Ontario, 45.5% of survey respondents selected bottled water as their primary household drinking water supply (Lavallee *et al.* 2021). The use of bottled/barreled water and filtered water from household water purifiers also reflects the rapid economic development in some parts of China and the relatively high income of residents. The low utilization rate of well water and filtered water of water purifiers in the community reflected the high popularity rate of using tap water in China, and the quality of drinking water supplied to residents is fully guaranteed.

3.3. Daily water intake

As shown in Table 2, the average daily total plain water intake was 1,666 ml/day, which is higher than the reported values of 1,493 ml/day for Koreans (Ji *et al.* 2010), 1,466 ml/day for Americans (Kahn & Stralka 2009), and 1,380 ml/day for Canadians (Roche *et al.* 2012). The total water intake was 1,805 ml/day, which is higher than the total fluid intake reported by Zhang *et al.* (2018) was 1,387 ml/day, and exceeds the adequate intakes set by the Chinese Nutrition Society. But, it is lower than the recommended value of total water intake for the USA (Patel *et al.* 2020), EFSA (2010), and WHO (2005). Direct plain water was the main contributor to the total water intake (approximately 67% of the total water). It was also the main contributor to the total plain water, accounting for approximately 73%. The intake of indirect plain water was 451 ml/day, which is close to the value of 477 ml/day for Koreans (Ji *et al.* 2010) and is lower than the intake of moisture in foods (664 g/day) of the adult US population (Yang & Chun 2014) and much lower than the findings in Japan with the value of 1,130 ml/day (Tani *et al.* 2015). Compared with people in the United States, Korea, and China, it is considered that people consume more water from food moisture due to the inclusion of boiled white rice, vegetables, and soup in Japanese meals. Commercial beverages contributed the least to the total water intake. Commercial beverages accounted for 7.7% of total water intake. This value was much lower than that contribution (including coffee, sweetened beverages, tea, fruit beverages, milk, and diet beverages) in the USA which accounted for 48.8% of total nonalcoholic beverage consumption (Martin *et al.* 2020). These commercial beverages on the market may constitute an important proportion of the daily water intake; however, they would not reflect the local water contamination, and hence would not be appropriate to be considered in the exposure assessment. The value of 1,666 ml/day is the average obtained through extensive surveys, which can represent

Table 2 | Average water intake (ml/day) of different ages, genders, and seasons

	Total plain water	Direct plain water	Indirect plain water	Beverages	Total water
All ($N = 13{,}106$)	1,666	1,215	451	139	1,805
Gender					
Male ($N = 6{,}290$)	1,777	1,303	474	166	1,942
Female ($N = 6{,}816$)	1,564	1,134	430	114	1,678
p-value	<0.001	<0.001	<0.001	<0.001	<0.001
Season					
Summer ($N = 6{,}741$)	1,794	1,327	467	150	1,944
Winter (N = 6,365)	1,531	1,097	434	127	1,657
p-value	<0.001	<0.001	<0.001	0.068	<0.001
Age (year)					
18–24 ($N = 1{,}512$)	1,541	1,144	398	227	1,769
25–34 ($N = 2{,}437$)	1,595	1,166	429	192	1,787
35–44 ($N = 2{,}345$)	1,764	1,291	473	139	1,902
45–54 ($N = 2{,}383$)	1,718	1,268	450	108	1,826
55–64 ($N = 2{,}259$)	1,712	1,244	468	96	1,808
≥ 65 ($N = 2{,}170$)	1,623	1,152	471	95	1,718
p-value	<0.001	<0.001	<0.001	<0.001	<0.001

the daily water intake of most Chinese adults. This value is proposed as the recommended value of the daily total plain water intake rate for use in exposure assessments in China.

3.4. Daily water intake between male and female

The water consumption rates by gender are shown in Table 2. The total plain water intake and total water intake were 1,777 and 1,942 ml/day for males, and 1,564 and 1,678 ml/day for females, respectively. The water consumption (including total plain water, direct plain water, indirect plain water, commercial beverages, and total water) was significantly higher in male adults than female adults ($p < 0.001$). This observation is similar to that of Ershow & Cantor (1989), Ji *et al.* (2010), Tani *et al.* (2015), and Zhang *et al.* (2018) who reported higher water consumption in males. This may be attributed to men's higher weight, body water content, and metabolism, men have greater average sweat rates than women, and women generally have smaller body sizes and lower metabolic rates when performing a given task than men (Buono & Sjoholm 1988).

3.5. Daily water intake between summer and winter

The water consumption rates in summer and winter are also shown in Table 2. The total plain water intake and total water intake were 1,794 and 1,944 ml/day in summer, and 1,531 and 1,657 ml/day in winter, respectively. The water consumption (including total plain water, direct plain water, indirect plain water, and total water intake) was significantly higher in summer than in winter. There was no significant difference in commercial beverage intake in summer and winter ($p = 0.068$). We found greater water consumption in summer than in winter. High temperature and humidity also might have exacerbated dehydration (Westerterp *et al.* 2005; Malisova *et al.* 2013). There are some relevant studies on the effect of hot weather on the water consumption rate. Tani *et al.* (2015) found that the mean total water intake was 2,230 ml/day (high in summer: 2,331 ml/day; low in winter: 2,134 ml/day). Ji *et al.* (2010) also reported higher tap water consumption during the summer. Regnier *et al.* (2015) found when the outdoor air temperature exceeded 90°F, water consumption increased by 28%. However, in England and Wales (DWI 2008), people do not decrease total tap water consumption in the winter. The reason is that tea and coffee accounted for 32 and 18% of all tap water consumption. Nearly 80% of the sample say they drink tea or coffee the same all year, and 16% tend to drink more tea or coffee in winter, while 4 and 1% said they drink more tea and coffee in summer.

3.6. Daily water intake of different age groups

The daily water intake of different age groups is also shown in Table 2. The total plain water intake ranged from 1,541 ml/day for the 18–24 age group adults to 1,764 ml/day for the 35–44 age group adults, and total water intake ranged from 1,718ml/day for the >65 age group adults to 1,902 ml/day for 35–44 age group adults. The water consumption (including total plain water, direct plain water, indirect plain water, and total water) was significantly higher in the 35–64 age groups than 18–34 and ≥65 age groups. However, commercial beverage consumption was the highest in the 18–24 age groups, and there is a significant downward trend with the increasing age. This is similar to Ershow & Cantor's (1989) observation of an increase in water consumption among subjects 45–64 years and a gradual decrease in older populations. The total tap water consumption rate of Koreans was greatest among the age group of 40–49 years, and the consumption rate decreased in age groups of >50 years (Ji *et al.* 2010). The reason is many older adults deliberately avoid drinking water because they fear nighttime incontinence (Asplund & Aberg 1991). Older adults may not recognize that they are thirsty as the sensation of thirst decreases with age (Kenney & Chiu 2001).

3.7. Daily water intake of different regions

The water consumption among different regions is summarized in Table 3. The cities in the major river basin in the central and southern regions of China had the highest intake of total plain water and total water. The cities in the major river basin in the northeast and west regions of China had the lowest intake of total plain water and total water. The direct plain water intake rate was the lowest, but the consumption of indirect plain water and commercial beverages was the highest in Beihai city. The region's effect on water consumption could be found in some other studies (Ershow *et al.* 1991; Zhang *et al.* 2018). The different water consumption in different regions may be caused by differences in climate conditions and differences in lifestyle (Ershow *et al.* 1991). People living in different places take nutrients from different kinds of food. The highest intake of indirect plain water and commercial beverages in Beihai city could be explained by the fact that local people are used to drinking soup and drink commercial beverages such as tea with milk.

3.8. Daily water intake varies by body mass index

BMI was assessed as an index of obesity. BMI = Weight (kg)/(Height (m))^2. The normal range is 18.5–22.9, slightly overweight is 23.0–24.9, overweight is 25.0–29.9, and obese is ≥30.0 (according to the standard of Asian BMI). Daily water

Table 3 | Daily water intake among different typical cities

Region	Total plain water	Direct plain water	Indirect plain water	Beverages	Total water
Mudanjiang	1,266	899	367	121	1,387
Wuxi	1,445	1,050	395	148	1,593
Lanzhou	1,503	1,168	335	145	1,648
Shenyang	1,527	1,176	350	189	1,716
Shehong	1,564	1,070	494	116	1,680
Tengchong	1,565	1,076	489	118	1,683
Pinghu	1,696	1,415	281	119	1,814
Chaohu	1,775	1,310	465	118	1,892
Changsha	1,804	1,490	314	129	1,933
Foshan	1,816	1,273	543	131	1,947
Korla	1,816	1,415	401	159	1,975
Hohhot	1,821	1,472	349	120	1,941
Beihai	1,834	990	845	198	2,032
Shijiazhuang	1,846	1,326	520	173	2,019
Zhengzhou	1,920	1,344	576	151	2,071
Tianjin	1,930	1,348	582	92	2,022
p-value	<0.001	<0.001	<0.001	<0.001	<0.001

consumption variation by different BMI is summarized in Table 4. The intake of total plain water, direct plain water, and total water significantly increased with BMI ($p < 0.001$). There was no significant association between the intake of beverages and indirect plain water and BMI ($p = 0.675$ and $p = 0.218$). The intake of commercial beverages was the highest in the group with a BMI $\geq$ 30, followed by a BMI < 18.5 groups. The intake of indirect plain water was the highest in the group of 25 $\leq$ BMI < 30. The association between water consumption and body weight outcomes is generally well-documented elsewhere. Fulgoni (2007) found that obese adults consumed more plain water than normal-weight adults. Kant *et al.* (2009) reported that plain water consumption was higher in adults of higher BMI groups. In this study, no significant correlation was found between BMI and the intake of commercial beverages and indirect plain water. This further illustrated that the relation between commercial beverage and indirect plain water consumption and BMI was not strong in the study population (Forshee *et al.* 2005).

Table 4 | Daily water intake of different body mass indexes

	Total plain water	Direct plain water	Indirect plain water	Beverages	Total water
BMI < 18.5 (*N* = 789)	1,522	1,095	426	154	1,676
18.5 ≤ BMI < 23 (*N* = 5,429)	1,630	1,181	449	148	1,778
23 ≤ BMI < 25 (*N* = 3,073)	1,667	1,223	443	123	1,789
25 ≤ BMI < 30 (*N* = 3,147)	1,760	1,289	471	127	1,887
BMI ≥ 30 (*N* = 372)	1,734	1,284	451	160	1,894
p-value	<0.001	<0.001	0.218	0.675	<0.001

Table 5 | Standardized coefficients and significance for various factors and daily water intake

		Standardized coefficients			
		Beta	Bootstrap (1,000) estimate of std. error	*F*	Sig.
Total plain drinking water	Season	0.1726	0.0078	491.1197	0.0000
	Region	0.2908	0.0077	1,415.7416	0.0000
	Age	0.0897	0.0085	110.8978	0.0000
	Gender	0.1297	0.0082	248.4750	0.0000
	BMI	0.0507	0.0091	31.0431	0.0000
Direct plain water	Season	0.1849	0.0078	561.1266	0.0000
	Region	0.2747	0.0081	1,142.9007	0.0000
	Age	0.0618	0.0086	51.0862	0.0000
	Gender	0.1141	0.0084	186.4122	0.0000
	BMI	0.0567	0.0087	42.3233	0.0000
Indirect plain water	Season	0.0425	0.0081	27.7661	0.0000
	Region	0.4429	0.0074	3,589.1582	0.0000
	Age	0.1104	0.0079	194.9025	0.0000
	Gender	0.0888	0.0080	122.4452	0.0000
	BMI	0.0099	0.0074	1.8183	0.1414
Beverages	Season	−0.0424	0.0079	28.5462	0.0000
	Region	−0.1372	0.0081	289.8736	0.0000
	Age	−0.2545	0.0088	830.0260	0.0000
	Gender	−0.1184	0.0088	180.9308	0.0000
	BMI	0.0126	0.0082	2.3590	0.0695
Total water	Season	−0.1800	0.0082	479.7932	0.0000
	Region	−0.2692	0.0074	1309.3078	0.0000
	Age	−0.0341	0.0082	17.2291	0.0000
	Gender	−0.1558	0.0084	340.7246	0.0000
	BMI	0.0558	0.0084	43.6899	0.0000

Table 6 | Correlations and importance of various factors and daily water intake

		Correlations				Tolerance	
		Zero-order	Partial	Part	Importance	After transformation	Before transformation
Total plain drinking water	Season	0.1709	0.1833	0.1726	0.2058	0.9999	0.9999
	Region	0.2866	0.2993	0.2903	0.5818	0.9968	0.9923
	Age	0.0865	0.0932	0.0867	0.0541	0.9340	0.9519
	Gender	0.1400	0.1374	0.1284	0.1268	0.9809	0.9810
	BMI	0.0890	0.0524	0.0486	0.0315	0.9195	0.9283
Direct plain water	Season	0.1802	0.1944	0.1848	0.2553	0.9997	0.9999
	Region	0.2700	0.2821	0.2742	0.5685	0.9964	0.9923
	Age	0.0606	0.0637	0.0595	0.0287	0.9291	0.9519
	Gender	0.1261	0.1202	0.1129	0.1103	0.9797	0.9810
	BMI	0.0857	0.0580	0.0542	0.0372	0.9141	0.9283
Indirect plain water	Season	0.0481	0.0479	0.0425	0.0095	0.9995	0.9999
	Region	0.4399	0.4472	0.4426	0.9008	0.9988	0.9923
	Age	0.0990	0.1212	0.1081	0.0505	0.9583	0.9519
	Gender	0.0912	0.0991	0.0882	0.0374	0.9854	0.9810
	BMI	0.0382	0.0109	0.0096	0.0018	0.9453	0.9283
Beverages	Season	−0.0444	−0.0446	−0.0424	0.0190	0.9999	0.9999
	Region	−0.1372	−0.1430	−0.1371	0.1901	0.9998	0.9923
	Age	−0.2536	−0.2587	−0.2543	0.6524	0.9978	0.9519
	Gender	−0.1149	−0.1237	−0.1183	0.1375	0.9980	0.9810
	BMI	0.0075	0.0132	0.0126	0.0009	0.9960	0.9283
Total water	Season	−0.1790	−0.1902	−0.1800	0.2359	0.9999	0.9999
	Region	−0.2718	−0.2779	−0.2688	0.5356	0.9973	0.9923
	Age	−0.0418	−0.0365	−0.0340	0.0104	0.9937	0.9519
	Gender	−0.1650	−0.1639	−0.1544	0.1882	0.9814	0.9810
	BMI	0.0732	0.0592	0.0551	0.0299	0.9782	0.9283

3.9. The impact of various influence factors on daily water intake

To reveal what season, gender, age, region, and BMI were associated with water consumption, we performed categorical regression analysis using these influence factors as independent factors (Table 5). Except BMI had no significant correlation with the intake of indirect plain water and commercial beverages, other factors were found to be associated with the intake of total plain water, direct plain water, indirect plain water, commercial beverages, and total water. BMI had a significant correlation with the intake of total plain water, direct plain water, and total water. From Table 6, we could see the region was the most important factor influencing the intake of total plain water, direct plain water, and total water, followed by season and gender. The intake of indirect plain water was mainly related to the region, and other factors had little influence on the indirect plain water intake. Age was the most important factor of the impact on the intake of commercial beverages, followed by region and gender.

4. CONCLUSIONS

The safety and quality of drinking water are of crucial significance to the health of both community and individuals. Data on the intake of plain water are utilized for multiple purposes. The application of appropriate water intake rates is important in assessing the risk of waterborne illness caused by chemical and microbiological hazards or in determining the limit value of a drinking water quality indicator. This study explored the drinking water intake of adults in typical cities within major river basins of China. The daily volume of water consumed daily was associated with age, gender, season, region, and BMI. The mean volume of total plain water consumed was 1,666 ml/day. The water intake rates reported in this study could be applied in China and other countries with similar geographical locations, temperatures, climates, and living customs.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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