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Original Article

Is Inadequate Water Intake a Risk Factor for Vestibular Disorders?

Büşra Altın, Songül Aksoy

Department of Audiology, Hacettepe University Faculty of Health Sciences, Ankara, Turkey

ORCID IDs of the authors: B.A. 0000-0002-7032-5658; S.A. 0000-0003-4584-5528

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BACKGROUND: Water is a vital nutrient for the human body system and failing to consume enough water could cause health problems. The purpose of this study is to investigate the relationship between water intake and vestibular system disorders.

METHODS: Data from 93 patients (aged between 20 and 76 years) with vestibular disorders were analyzed in the study. The mean age of the patients was 46.96 ±13.94 years (female: 45.68 ±13.45, male: 49.96 ±14.85), and 69.9% (n = 65) were female. Participants were sub-categorized into diagnostic groups as follows: benign paroxysmal positional vertigo, Meniere's disease, vestibular neuritis, vestibular migraine, and persistent postural perceptual dizziness. The water intake information was analyzed for total water, plain water, and caffeinated beverages separately and compared between groups.

RESULTS: There was a significant difference between vestibular neuritis and benign paroxysmal positional vertigo ($P < .001$) and also between vestibular neuritis and Meniere's disease ($P = .021$) in terms of the intake values of plain water and total water. No significant difference was found between groups in caffeinated beverages intake ($P = .151$), and it was found that there is no statistically significant difference in plain water and total water intake in terms of gender ($P > .05$).

CONCLUSION: The most significant result of this study is that inadequate water intake can be a risk factor for some forms of peripheral vestibular disorders. People should be informed about the importance of drinking water and be encouraged to increase their water intake.

KEYWORDS: Vestibular diseases, water intake, vertigo, caffeine

INTRODUCTION

Water is the most important component of nutrition, and it plays a vital role in all biochemical reactions, from the digestion, absorption, and transport of nutrients to energy production in the human body.[1]

Fluid balance in the body is controlled by homeostatic mechanisms that are sensitive to even small changes. These mechanisms try to re-establish the fluid balance and are activated based on the state of water in the body. Water passes through the membranous labyrinth in various ways: one of them is through water channels known as aquaporins (AQPs). AQP-2 contributes to the transportation of water through the cochlear duct epithelium. AQP-2 is regulated by the arginine vasopressin hormone (AVP) and plays a role in the homeostasis of the entire body fluid.[2] In the situation of low water intake, the plasma AVP level increases and AVP secretion from the posterior lobe of the pituitary gland increases.[3]

In the body, a decrease in the amount of water intake may cause problems with several functionalities of the human body. Although studies in this area are limited, it is inferred that dehydration may affect physical and cognitive performance, kidney, heart, and gastrointestinal function and cause headaches and chronic diseases.[4] The prevalence of dehydration is estimated to be between 16% and 30%, depending on the age, the risk of dehydration, and the associated increase in morbidity, mortality, and disability due to aging.[5,6] Even 1-2% dehydration of bodyweight negatively affects physiological function and performance.[7] Moreover, repeated psychological pressure may cause increased receptor activity of the AVP hormone (stress hormone), despite sufficient water intake. Also, the activation of the AVP neurons in the hypothalamus was detected due to the vestibular activation or inhibition-induced imbalance between vestibular activities in rats.[8]

Corresponding author: Büşra Altın, e-mail: ody.busra@gmail.com

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Problems in any of the somatosensory, visual, and vestibular systems involved in postural control may affect balance and cause vertigo. The etiology of vestibular problems varies considerably between the region of damage and age groups. Vertigo may originate from the inner ear, brainstem, or cerebellum, as well as due to metabolic, cardiovascular, or psychiatric problems. In the beginning, the most common vestibular disorders are benign paroxysmal positional vertigo (BPPV), vestibular migraine (VM), Meniere's disease (MD), vestibular neuritis (VN), and persistent postural perceptual dizziness (PPPD),[9,10] Vertigo is one of the most common reasons for visiting a health facility,[11] and the prevalence of vertigo is estimated to affect 7-30% of the general population.[10,12,13] Since vertigo is very common, vestibular problems create a significant health burden on individuals and society, and the diagnosis and treatment of these conditions are considered important issues in primary care.[14] Thus, it is pertinent to determine the risk factors associated with the diagnosis and treatment of vestibular diseases.

This study has two primary aims: (1) to investigate the amount of water intake in vestibular patients and (2) to ascertain the relationship between different vestibular disorders and water consumption.

MATERIALS AND METHODS

This was a retrospective study conducted at the Hacettepe University Hospital. The study was approved by the ethics committee of the Hacettepe University (GO 20/516). The data of patients with vertigo complaints who visited the Audiology Department between January 2015 and December 2019 were included in the study.

Participants

We enrolled in 200 participants, of which only 93 patients (aged between 20 and 76 years) were available and 107 patients were excluded, mainly because of inadequate/uncertain data about the water consumption values. The mean age of the patients was 46.96 ±13.94 years (female: 45.68 ±13.45, male: 49.96 ±14.85) and 69.9% (n = 65) were female. The data for patients under 18 years and who have no information about water consumption were excluded from this study.

Assessment

Two audiologists reviewed all the medical records of the subjects. These comprised as follows:

a. Demographic data.
b. Diagnosis (BPPV, MD, VN, VM, and PPPD).
c. Water intake information [Total Water (TW) = Plain Water (PW) + Caffeinated Beverages (CB)].

The recorded patient history forms were checked and the data of the patients about their average daily water consumption values on a usual day and not the 24-hours recall method was included in the study. Even though the 24-hours diet recall method was the most frequently used method to calculate beverage intake,[15] this method has some limitations. Water consumption varies day to day and especially climate changes affect the amount of consumption. Also, patients with vestibular problems may limit their water consumption because of frequent vomiting and nausea complaints.

Statistical Analysis

Statistical analyses were performed using the SPSS statistical software version 26 (IBM SPSS Corp.; Armonk, NY, USA). The subject's age, gender, and amount of water intake were investigated using histograms and Shapiro-Wilk's test to determine whether or not they are normally disturbed. As the PW, CB, and TW intake values were not normally distributed, the Kruskal–Wallis tests were conducted to compare these parameters among the diagnostic groups. The Mann–Whitney U-test was used to test the significance of pairwise differences using Bonferroni correction to adjust for multiple comparisons. The chi-square test or Fisher's exact test, where appropriate, was used to compare the numbers of males and females in different groups of diagnosis. The Spearman correlation analysis was performed to determine whether or not the age of the participants correlated with the amount of water intake. Results were considered significant at a P-value $< .05$.

RESULTS

The study was conducted on 93 patients and they were divided into 5 groups in terms of diagnosis. The medical diagnosis of the subjects as classified into 5 groups was as follows: BPPV in 36 patients (38.7%), MD (34,4%) in 27, VM (10.75%) in 10, PPPD (8.6%) in 8, and VN (7.52%) in 7 patients. The distribution of diagnosis, age, and gender of the patients in groups are shown in Table 1, and the water consumption values of the diagnostic groups were shown in Figure 1.

The groups are distributed homogeneously and there is no significant difference between the groups in terms of age ($P = .40$), and it was found no statistically significant difference between the genders of diagnostic groups ($P = .89$).

No statistically significant differences were found in PW ($F = 0.5$ L/day, $M = 0.4$ L/day, p=0.549), CB ($F = 0.6$ L/day, $M = 0.5$ L/day, $P = 0.615$), and TW intake ($F = 1.0$ L/day, $M = 1.0$ L/day, $P = 0.504$) in terms of gender. According to their diagnosis, the median values of the water intake of patients were shown in Table 2. The Kruskal–Wallis test showed that there were statistically significant differences in the values of TW and PW between the groups ($P < .001$). It was found that there was a statistically significant difference between the groups of VN and BPPV ($P < .001$) and between the groups of VN and MD ($P = .021$) in terms of PW. Additionally, in TW intake, there was a statistically significant difference between VN and BPPV ($P < .001$) and also between VN and MD ($P = .023$). But no significant difference

Table 1. Distribution of Age and Gender in Groups

Diagnosis	Female (n)	Male (n)	Total % (n)	Age (Mean ± SD)
BPPV	58.33% (21)	41.66% (15)	38.7% (36)	48.86 ±12.92
MD	84.37% (27)	15.62% (5)	34.4% (32)	44.75 ±14.45
VM	70% (7)	30% (3)	10.75% (10)	52.3 ± 12.61
VN	85.71% (6)	14.28% (1)	7.52% (7)	45.37 ± 6.96
PPPD	50% (4)	50% (4)	8.60% (8)	41.57 ± 10.22
Total	69.9% (65)	30.1% (28)	100% (93)	46.96 ± 13.94

BPPV, benign paroxysmal positional vertigo; MD, Meniere's disease; VN, vestibular neuritis; VM, vestibular migraine; PPPD, psychogenic/persistent postural perceptual dizziness; SD, standard deviation.

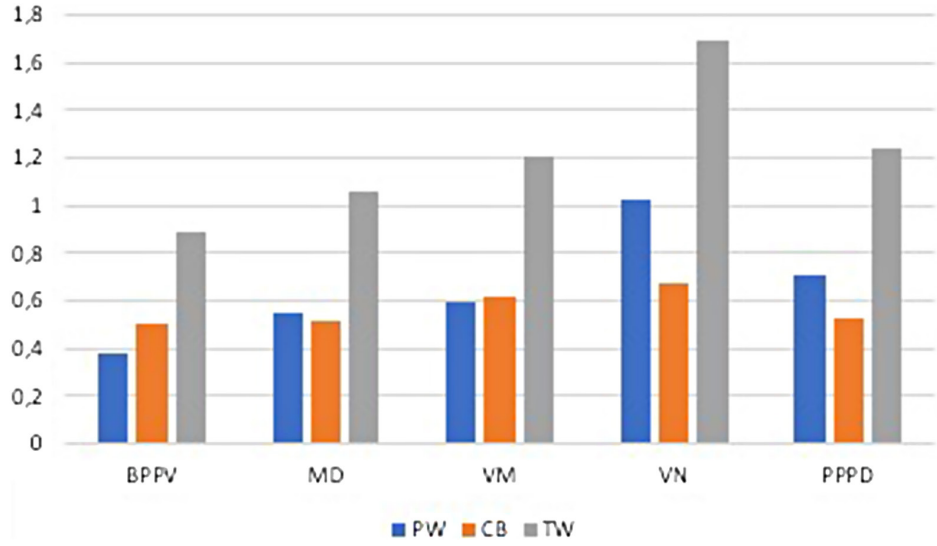

Figure 1. The water consumption values of the diagnostic groups.

was found between groups in CB intake ($P = .151$). The comparison results were shown in Table 3.

As a result of the correlation analysis, there was a moderate positive correlation between TW and CB intake ($r = 0.429$, $P < .05$) and also it found a strong correlation between TW and PW intake ($r = 0.881$, $P < .05$). However, there is no significant correlation between CB and PW intake ($P = .634$), and there is a weak negative correlation between age and the amounts of PW ($r = -0.306$) and TW ($r = -0.241$) intake. There was no significant correlation between the amount of CB intake and age ($P = .475$). Lastly, no significant correlation was found between climate changes and water intake values ($P > .05$).

DISCUSSION

This retrospective case series comprised the data of 93 patients with vertigo complaints. It was found that the TW intake of the participants was between 0.3 L and 2.9 L and the median TW intake was 1 L/day and 1 L/day for males and females, respectively. Although it was known that women in the same population consumed less water than men,[16] no significant difference was found between the genders in our study. However, the consumption values of our patients were less than adequate consumption values suggested by the European Food Safety Authority (EFSA)[17] and the Food and Nutrition Board of the Institute of Medicine (IOM).[6] For young men and women (between 19 and 30 years old), consumption values determined by IOM are 3.7 L/day and 2.7 L/day, respectively,[6] while EFSA's recommendation is 2.5 L/day for adult men and 2.0 L/day for adult women. These values include water from all kinds of beverages and foods. Although it is estimated that approximately 20-30% of daily water intake is taken from food, this rate may vary according to the climate and cultural characteristics of the region.[17] It also varies depending on the age; PW is the primary water source, with an approximately 40% (5-80%) rate of intake, but this rate decreases with age.[15] In contrast to the findings from previous studies, the present study showed that the consumption of PW and CB was the same. The median fluid intake of the patients in our study was 0.50 L for PW, 0.55 L for CB, and 1 L for TW per day.

Because of the diuretic effect of CB, there is an approximately 753 mL increase in urine excretion in those who consume 1.42 L of coffee (642 mg caffeine) per day.[18] Diuretics are thought to affect the ion pumps and ionic components in the kidney, as well as the inner ear fluid and electrolyte balance.[19] According to the EFSA, while coffee is the largest contributor to CB,[20] the majority (>80%) of CB consisted

Table 2. The Water Consumption Values in Groups (L/day)

	Diagnosis of the Groups					
Amount of Water	**BPPV (L)**	**MD (L)**	**VM (L)**	**VN (L)**	**PPPD (L)**	**Total (L)**
Plain water						
median	0.35	0.50	0.50	1.0	0.70	0.50
IR	0.30	0.27	0.55	0.10	0.57	0.30
Caffeinated beverages						
median	0.50	0.55	0.65	0.80	0.50	0.55
IR	0.20	0.20	0.30	0.30	0.30	0.20
Total water						
median	0.90	1.10	1.05	1.60	1.25	1.0
IR	0.30	0.47	0.80	0.30	0.42	0.50

L, liter; BPPV, benign paroxysmal positional vertigo; MD, Meniere's disease; VN, vestibular neuritis; VM, vestibular migraine; PPPD, psychogenic/persistent postural perceptual dizziness; SD, standard deviation.

Each cell contains the median and IR (interquartile range).

Table 3. Comparison of the Diagnostic Groups in Terms of Water Consumption Values

		Plain Water *P*	Caffeinated Beverages *P*	Total Water *P*
BPPV	MD	.169	1.00	.250
	VM	.855	1.00	.401
	VN	.000*	.576	.000*
	PPPD	.120	1.00	.085
MD	VM	1.00	1.00	1.00
	VN	.021*	.780	.023*
	PPPD	1.00	1.00	1.00
VM	VN	.113	1.00	.277
	PPPD	1.00	1.00	1.00
PPPD	VN	.885	1.00	1.00

BPPV, benign paroxysmal positional vertigo; MD, Meniere's disease; VN, vestibular neuritis; VM, vestibular migraine; PPPD, psychogenic/persistent postural perceptual dizziness. Significant values have been adjusted by the Bonferroni correction for multiple tests, *the mean difference is significant at the 0.05 level.

of black tea in our study. Given the cultural characteristics of Turkish people, black tea is generally preferred. Unal et al[21] reported that more than 90% of the participants drank black tea for breakfast and snacks in their study on 3411 Turkish participants. In our study, the combined consumption of tea and coffee was calculated under CB; however, tea (one cup of tea: 50 mg) contains approximately twice the caffeine contained in the same amount of coffee. Also, Ruxton et al[22] reported that black tea has no significant difference from water for blood or urine measurements, and it has similar hydrating properties to water at intakes of between 960 mL and 1440 mL (168-252 mg caffeine).

A survey conducted in Canada found the average daily water consumption was 1.0 L. While this water consumption was reported to decrease with age,[23] we found a weak negative relationship between age and water consumption in our study. The EFSA was reported that the average daily water intake of European countries ranged from 720 mL to 2621 mL.[17] In the American population, daily water intake is 1.141 L (38.6 oz) in summer and 1.023 L (34.6 oz) in winter.[24] The fact that there is so much difference between countries with approximately the same climatic conditions and cultural structure shows that the climate and cultural structure are not the main determinants of water consumption, but other factors should be investigated. A study conducted in Turkey showed that the daily average total fluid consumption was 2270 mL (water: 1470 mL/day, other beverages: 800 mL/day).[21] However, no significant correlation was found between climatic changes and water consumption in our study.

Adequate water intake has a positive effect on health by providing hydration.[4] Jormeus et al[25] reported a significant decrease in vertigo complaints when the daily water consumption increased from 1.7 $\pm$ 0.59 L/day to 3.7 $\pm$ 0.84 L/day. In their study, the participants' complaints were evaluated using a visual analog scale (VAS) and when the water consumption was doubled, the VAS score decreased from 3.1 $\pm$ 2.6 to 2.1 $\pm$ 2 points. Since the participants in the study were healthy young adults, their initial VAS scores were not high. In another study by Park et al.[26] it was found no significant difference between the water intake amounts of individuals with positional vertigo complaints (1.011 L) and healthy individuals (1.125 L). Since the diagnoses of the participants were not specified, and it was not explained whether the amount of water consumption mentioned in the study was PW or TW, a comparison could not be made with our results.

Although BPPV is one of the leading disorders causing positional vertigo, it occurs approximately in 50% of the patients with idiopathic causes. It is thought that trauma, migraines, inner ear problems, diabetes, osteoporosis, and certain head positions for an extended time may be associated with BPPV.[9] According to our results, there were significant differences between VN and BPPV in terms of PW and TW intake. We believe that low levels of water intake could also be a risk factor for BPPV because of the sensitivity of the posterior labyrinth to conditions that alter body homeostasis. Also, Kim et al[27] reported that central actions of AVP could be the cause of nausea and motion sickness in humans.

In our study, the second most common disease after BPPV (38.7%) was MD, which afflicted 34.4% of the cases. The median TW consumption of patients with MD was 1.10 L/day. We observed that these patients consumed significantly less PW and TW than patients with VN and their water intakes were lower than those determined by the EFSA. Naganuma et al[3] reported that patients with MD experience improvements in symptoms in the long term when their daily water consumption increased by 0.35 L. This group also stated that increasing the water intake of patients could be the most cost-effective and simplest method in treating MD. High water intake maintains plasma osmolality within the normal range and decreases vasopressin hormone levels. Thus, low AVP levels help for the regulation of water permeability in the inner ear structures and prevent endolymphatic hydrops.[3] However, not only low water intake but also high-stress level might increase AVP levels in plasma.

In our study, no significant difference was found in caffeine consumption (0.55 L/day) in patients with MD compared with other diagnostic groups. Participants in our study were thought to consume 100 mg to 150 mg of caffeine daily. However, Sánchez-Sellero et al[28] were reported that there is a significant difference between patients with MD (222 mg/day) and those without vertigo (140 mg/day) in the mean daily caffeine intake. They also found a significant difference in caffeine intake among patients with MD and VN, and BPPV (104 mg/day). Although caffeine consumption in patients with MD is a controversial issue, there is a consensus on limiting caffeine intake, considering that caffeine may cause modifications in endolymph volume. On the other hand, it has been concluded that low amounts of caffeine, such as 100 mg/day, do not trigger MD symptoms.[29]

It is hard to differentiate MD from VM in some cases because of the similarities in patient histories. It was recently reported that VM is the most common cause of medical consultation after BPPV.[14] Water deprivation can trigger migraine or prolong the duration of attacks by affecting intracranial dehydration and total plasma volume; however, there is insufficient evidence that an increased water intake will reduce the number of attacks.[4] The median TW consumption of patients with VM was 1.05 L/day in our study. Although there was no statistically significant difference with other groups in terms of water intake, the levels were below the recommended water intake for healthy individuals.

The major limitation of this study is the small sample of participants and, in future studies, it is planned to increase the number of cases. Aside from the diuretic effect of CB, the effects of coffee on metabolism differ from tea and other CB. However, it is unfortunate that the study did not include drinking water, CB, and also the amount of water in the food separately.

CONCLUSION

Water is an essential nutrient for health, but its importance is often overlooked. It is observed that the water consumption of individuals with vestibular vertigo is well below the recommended values. The results of this investigation show that there can be a relationship between water consumption and vertigo. Taken together, these findings suggest a role of inadequate water intake in promoting vestibular disorders. As vertigo is an important problem that affects the quality of life and increases the risk of falling, even a minimum reduction in vertigo complaints is a considerable improvement. It is expected that the results of this study will contribute to and raise awareness of water intake and its importance in the prevention and treatment of vertigo, which causes a huge burden on patients and the healthcare system. However, further research is required to establish the diagnostic and therapeutic efficiency of water intake.

Ethics Committee Approval: Ethical committee approval was received from the Ethics Committee of Hacettepe University, (Approval No: GO 20/516).

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

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