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Associations between headache and stress, alcohol drinking, exercise, sleep, and comorbid health conditions in a Japanese population

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Abstract We conducted a cross-sectional survey of 12,988 subjects aged 20–79 years (5,908 men and 7,090 women) receiving health checkups at a Tokyo clinic. They filled out a self-administered structured questionnaire, and 5.4% of the men and 15.4% of the women reported having headaches. Younger subjects were more prone to having headaches. The likelihood of having headaches increased with stress level and decreased ability to relieve stress in both genders. There was an inverse dose–response relationship between having headaches and alcohol consumption, and less walking/exercise and sleep problems increased the likelihood of headaches in both genders. Headache sufferers of both genders were more likely to report multiple additional poor health conditions. A multivariate stepwise logistic analysis showed that age, self-estimated degree of stress, reported number of additional poor health conditions, and less alcohol consumption were independently correlated with having headaches. In conclusion, although women were more susceptible to headache, Japanese men and women in Tokyo shared factors associated with headache, including age, stress, having other poor health conditions, alcohol consumption, sleep, and exercise.

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Introduction

Headaches rank among the most frequent complaints in the general and working populations [1] and they can affect the quality of life and work productivity [2] Headache sufferers tend to complain of other pains in various parts of the body [3, 4] and a wide range of lifestyle choices, including drinking, smoking, and exercise, may be involved in headache occurrence. Stress and poor sleep are frequently cited on lists of headache triggers. Headache sufferers often report that drinking alcohol is related to some of their headaches. Headaches are also a frequent symptom of both alcohol-induced flushing responses and hangover in the Japanese with inactive acetaldehyde dehydrogenase-2 (ALDH2), who fail to promptly eliminate acetaldehyde, a toxic metabolite of ethanol [5, 6]. The genetic variation prevalent in the Japanese may modify the interaction between headache and alcohol consumption. In the present study, we investigated the associations between headaches and various lifestyle choices and comorbid conditions in a very large Japanese general population in Tokyo.

Subjects and methods

The reference population of this study consisted of 16,290 Japanese who came to Mitsukoshi Clinic of Tokyo for an annual health checkup between January 2004 and December 2004. They were workers or residents of Tokyo or of neighboring areas, who had been registered on the clinic lists for annual health checkups. They were routinely

asked to fill out a self-administered structured questionnaire concerning their physical condition, stress, exercise, sleep, and drinking and smoking habits for clinical use, and 13,001 of them completed all items related to stress, exercise, sleep, and drinking and smoking habits. After excluding the three persons aged 80 years or more, 12,988 persons (5,908 men and 7,090 women) who were aged 20–79 years were adopted as the subjects of this study.

Each subject was asked to indicate from the following, the poor health conditions that applied to them: I have headaches; I have lost weight; I get tired easily; I have little energy; I have little appetite; I have pain in my upper abdomen; I have pain in my lower abdomen; food sticks in my throat; I have heartburn; I have a heavy feeling in my stomach; I have nausea or vomiting; I have blood in my stools; I feel tightness in my chest; I have palpitations or shortness of breath; I have a cough or cough up sputum; I have blood in my sputum; I have low back pain; my limbs feel numb; my limbs hurt; my limbs are swollen; my hands shake; I sometimes feel dizzy; I have ringing in my ears; I get up to urinate at night; I am anxious sometimes; and I cannot sleep well.

The questionnaire asked the subjects to estimate their degree of stress in comparison with others by choosing from: little or none; low; average; somewhat high; very high, and their ability to relieve stress by choosing from: good; fairly good; little; and none. The choices for the average duration of sleep were: less than 5 h; 5 h to less than 6 h; 6 h to less than 8 h; and 8 h or more. The questionnaire also asked the subjects to report alcohol intake as frequency of consumption per week and the usual amount(s) and type(s) of alcoholic beverage(s) consumed per day. Subjects were classified as non-drinkers or as current drinkers who consumed less than 1 unit/day (1 unit = 22 g ethanol, the ethanol content of one serving of sake), 1 unit to less than 2 units/day, 2 units to less than 3 units/day, and 3 units/day or more. The subjects were asked to report on smoking and weekly frequency of walking or exercise for at least 20 min at a time or at least a total of 1 h a day. The choices for frequency of walking or exercise were: seldom; 1 day/week; 2 days/week; 3–4 days/week; and 5 days/week or more. Blood pressure measurements were made in the arm, with an automated sphygmomanometer (BP-103iII, Omron Healthcare Co. Ltd., Kyoto) between 9:00 am and 11:00 am and with the subjects in the sitting position. The subjects were requested to refrain from eating and drinking for at least 12 h and from smoking for at least 30 min before the examination. The subjects were divided into four groups according to systolic pressure measured at the time of the health checkup: under 100, 100–119, 120–139, and 140 mmHg and over.

This study was conducted following the Ethical Guidelines for Epidemiological Research in Japan and reviewed and approved by the Ethics Committee of Mitsukoshi Health and Welfare Foundation.

Statistical analysis

Data are summarized as percentage values, and the chi-squared test was used for comparisons between groups. The relationships between headache and lifestyle and health conditions are expressed as odds ratio (OR) and 95% confidence interval (CI) estimated by a multiple logistic regression model with adjustment for age and other confounding factors. The stepwise procedure with $P < 0.05$ for entry and removal was used to select independent significant factors. All statistical analyses were performed using SAS software (version 9.1, SAS Institute, Cary, NC).

Results

Prevalence of headache

Table 1 shows the proportions of subjects who reported having headaches according to gender and age group. Of the 12,998 subjects, 1,411 (5.4% of the men and 15.4% of the women) reported having headaches. A significantly higher rate of women reported having headaches than the men in all age brackets. The younger subjects were more prone to having headaches, regardless of gender. Headache ranked 3rd in women and 11th in men among the poor physical conditions asked in the questionnaire.

Headaches and stress

The likelihood of having headaches increased in stepwise fashion with stress level and decreased ability to relieve stress, in both men and women (Table 2). The subjects whose self-estimated degree of stress was “little or none” had the lowest rate of headache (1.5% of men and 6.1% of women) among all the subcategories of lifestyles evaluated in this study, in contrast to the highest rate (18.1% of men and 30.7% of women) among the subjects whose ability to relieve stress was “none”. The age-adjusted ORs for the highest versus lowest level of stress and the lowest versus highest ability of stress release in men were approximately twofold stronger than in women (11.74 vs. 4.9 and 6.96 vs. 3.52, respectively).

Headaches and alcohol

Current drinkers, both men and women, had a lower likelihood of headaches than non-drinkers, regardless of the amount consumed (ORs = 0.51–0.76 for men and

Table 1 Proportion of headache sufferers based on gender

Age (year)	Men		Women		*P**
	N	Proportion of headache sufferers (%)	*N*	Proportion of headache sufferers (%)	
20–29	236	12.3	707	16.8	NS
30–39	1,113	7.9	1,890	18.6	<0.0001
40–49	1,582	5.4	1,609	15.2	<0.0001
50–59	2,119	4.4	1,975	13.7	<0.0001
60–69	811	2.7	714	11.9	<0.0001
70–79	47	4.3	195	8.7	NS
Total	5,908	5.4	7,090	15.4	<0.0001
		$P < 0.0001$**		$P < 0.0001$**	

* *P* men versus women by χ^2 test

** *P* for homogeneity among age groups by χ^2 test

0.39–0.77 for women). There was an inverse dose–response relationship in both the men and the women.

Headaches and exercise

There was an inverse association between having headaches and walking/exercise that was significant among the men and marginally significant among the women. When "seldom" was used as the referent, the lowest significant risk for headache for both men and women was in the "2 days/week" category (OR = 0.53 for men and 0.71 for women).

Headaches and sleep

When 6 h to less than 8 h sleep was used as the referent, both less sleep (ORs = 1.63–2.04) and excessive sleep (OR = 1.89) in men, and less sleep (ORs = 1.31–1.33) in women were positively associated with having headaches.

Headaches and smoking

There was no association between having headaches and smoking.

Headaches and blood pressure

There was no association between having headaches and systolic blood pressure.

Headaches and poor health condition

Headache sufferers of both genders were more likely to report multiple other poor health conditions (Tables 3, 4). The multivariate stepwise logistic regression model showed that the physical conditions that were significantly and independently associated with headaches were fatigability, upper abdominal pain, lower abdominal pain, heavy feeling in the stomach, lower back pain, palpitations or shortness of breath, dizziness, ringing in the ears, and anxiety in both men and women, and heartburn, nausea, chest tightness, swollen limbs, getting up to urinate at night, and sleep disturbance in women alone. The likelihood of having headaches increased greatly with the number of poor health conditions reported.

Analysis in a multivariate logistic regression model, of which independent variables were selected from all the factors by a stepwise procedure showed that age, self-estimated degree of stress, reported number of additional poor health conditions, and less alcohol consumption were independently related to headaches in both men and women and that the effects of the remaining factors no longer reached significance (Table 5).

Discussion

This cross-sectional large survey of headaches in a Tokyo population showed that men and women shared several factors associated with headache, but that women were much more susceptible to headaches. A multivariate analysis demonstrated that age, self-estimated degree of stress, reported number of comorbid poor health conditions, and less alcohol consumption were independently related to having headaches in both men and women. Since we used a simple questionnaire to ask subjects to indicate if the item "I have headaches" applied to them, it is impossible to classify the types of headaches in this study. One of the authors (M.Y.), a board-certified neurologist, informed the workers of a Tokyo company about the results of the health checkup and interviewed all 99 workers (29 men and 70 women aged 20–59 years; 7.0% of the present headache sufferers) who had replied that the questionnaire item "I have headaches" applied to them during the health

Table 2 Relationship between headache and lifestyle choices

	Men				Women			
	N	Proportion of headache sufferers (%)	Age-adjusted OR	95%CI	*N*	Proportion of headache sufferers (%)	Age-adjusted OR	95%CI
Stress								
Very high	305	16.7	11.74	4.16–33.15	484	25.4	4.90	2.75–8.75
Somewhat high	1,364	8.4	5.37	1.96–14.76	1,706	22.2	4.10	2.36–7.13
Average	3,307	3.9	2.56	0.94–6.99	4,001	12.8	2.15	1.24–3.72
Low	662	3.5	2.37	0.81–6.94	666	8.9	1.48	0.81–2.71
Little or none	270	1.5	1.00	Referent	231	6.1	1.00	Referent
			$P < 0.0001$				$P < 0.0001$	
Ability to relieve stress								
Good	2,489	3.0	1.00	Referent	2,728	10.9	1.00	Referent
Fairly good	2,272	6.3	2.11	1.58–2.81	2,824	15.0	1.41	1.21–1.66
Little	1,074	8.3	2.76	2.00–3.80	1,416	22.9	2.39	2.01–2.84
None	72	18.1	6.96	3.63–13.34	114	30.7	3.52	2.32–5.34
			$P < 0.0001$				$P < 0.0001$	
Drinking								
Non-drinker	1,410	7.5	1.00	Referent	4,366	16.5	1.00	Referent
Less than 1 unit/day	1,688	6.2	0.76	0.57–1.01	1,883	14.0	0.77	0.66–0.90
1 to less than 2 units/day	1,287	4.2	0.56	0.40–0.79	585	13.0	0.72	0.56–0.93
2 to less than 3 units/day	789	3.9	0.55	0.36–0.83	154	7.8	0.39	0.22–0.71
3 units/day or more	734	3.5	0.51	0.32–0.79	99	11.1	0.59	0.31–1.11
			$P = 0.0009$				$P < 0.0001$	
Walking or exercise								
5 days/week or more	2,042	4.9	0.68	0.50–0.92	2,297	14.7	0.85	0.72–1.01
3–4 days/week	1,069	5.2	0.77	0.54–1.10	1,658	15.4	0.93	0.77–1.13
2 days/week	859	3.7	0.53	0.35–0.81	889	12.5	0.71	0.56–0.90
1 day/week	745	6.3	0.88	0.61–1.28	665	15.5	0.88	0.68–1.12
Seldom	1,193	7.2	1.00	Referent	1,579	17.7	1.00	Referent
			$P = 0.020$				$P = 0.063$	
Sleep								
Less than 5 h	305	9.2	2.04	1.33–3.14	510	17.1	1.33	1.03–1.70
5 to less than 6 h	2,127	7.0	1.63	1.28–2.08	2,957	17.2	1.31	1.15–1.50
6 to less than 8 h	3,279	4.0	1.00	Referent	3,476	13.7	1.00	Referent
8 h or more	196	6.1	1.89	1.02–3.51	142	10.6	0.76	0.44–1.32
			$P < 0.0001$				$P = 0.0003$	
Smoking								
Never smoker	2,370	5.4	1.00	Referent	5,559	15.0	1.00	Referent
1–19 cigarettes/day	1,016	6.3	1.07	0.78–1.46	884	16.9	1.05	0.87–1.28
20–29 cigarettes/day	1,304	5.4	0.98	0.73–1.33	216	14.8	0.92	0.63–1.35
≥30 cigarettes/day	493	5.7	1.09	0.71–1.67	30	20.0	1.42	0.58–3.49
Ex-smoker	725	4.1	0.75	0.50–1.14	400	17.0	1.07	0.82–1.41
			$P = 0.60$				$P = 0.87$	
Blood pressure, systolic								
<100 mm Hg	525	5.9	1.00	0.67–1.50	2,374	15.7	0.98	0.85–1.14
100–119 mm Hg	2,304	6.0	1.00	Referent	3,008	15.4	1.00	Referent
120–139 mm Hg	2,254	5.1	0.92	0.71–1.19	1,343	15.3	1.13	0.94–1.36
≥140 mm Hg	825	4.6	1.03	0.70–1.50	365	12.9	1.04	0.75–1.45
			$P = 0.89$				$P = 0.54$	

P values are for homogeneity among the subcategories of each factor by the age-adjusted logistic regression model

Table 3 Relationship between having headaches and other poor health conditions in men

	Men									
	Other poor health conditions				Age-adjusted model			Multivariate model*		
	Absent		Present							
	N	Proportion of headache sufferers (%)	*N*	Proportion of headache sufferers (%)	OR	95%CI	*P*	OR	95%CI	*P*
Other poor health conditions										
Poor appetite	5,849	5.3	58	19.0	3.76	1.91–7.41	0.0001			
Weight loss	5,654	5.4	253	5.9	1.10	0.64–1.88	0.7360			
Feeling of food sticking in the throat	5,813	5.3	94	14.9	3.71	2.07–6.67	<0.0001			
Upper abdominal pain	5,799	5.1	108	20.4	4.77	2.93–7.77	<0.0001	1.81	1.02–3.21	0.0435
Lower abdominal pain	5,819	5.2	88	20.5	4.99	2.91–8.56	<0.0001	2.48	1.32–4.67	0.0047
Easy fatigability	5,038	3.9	869	14.2	3.65	2.87–4.65	<0.0001	2.20	1.68–2.88	<0.0001
Heartburn	5,648	5.0	259	13.9	3.52	2.41–5.13	<0.0001			
Heavy feeling in the stomach	5,556	4.8	351	14.3	3.27	2.36–4.53	<0.0001	1.80	1.25–2.59	0.0017
Chest tightness	5,757	5.1	150	16.0	3.65	2.31–5.76	<0.0001			
Lower back pain	4,621	4.2	1,286	9.6	2.68	2.11–3.40	<0.0001	1.86	1.44–2.41	<0.0001
Numbness	5,513	5.2	394	7.6	1.81	1.22–2.69	0.0035			
Palpitations/shortness of breath	5,626	4.9	281	16.0	4.35	3.07–6.16	<0.0001	1.84	1.23–2.76	0.0033
Edema	5,710	5.1	197	14.7	3.44	2.27–5.22	<0.0001			
Tremor	5,847	5.3	60	16.7	3.78	1.88–7.59	0.0002			
Loss of energy	5,394	5.3	513	6.8	1.76	1.21–2.56	0.0032			
Limb pain	5,703	5.1	204	12.8	3.24	2.10–5.01	<0.0001			
Dizziness	5,681	4.7	226	23.5	6.83	4.87–9.58	<0.0001	3.25	2.21–4.78	<0.0001
Cough/sputum	5,225	5.1	682	7.9	1.75	1.29–2.38	0.0004			
Bloody sputum	5,892	5.4	15	20.0	4.81	1.33–17.38	0.0165			
Nausea/vomiting	5,844	5.2	63	20.6	4.18	2.23–7.84	<0.0001			
Ringing in the ears	5,509	4.9	398	11.8	3.41	2.43–4.79	<0.0001	1.82	1.24–2.68	0.0023
Bloody stools	5,821	5.3	86	12.8	2.73	1.43–5.23	0.0024			
Urination during the night	5,569	5.4	338	6.2	1.84	1.14–2.98	0.0131			
Anxiety	5,452	4.8	456	12.5	2.67	1.97–3.63	<0.0001	1.43	1.01–2.02	0.0449
Sleep disturbance	5,458	5.0	449	10.9	2.28	1.65–3.15	<0.0001			
Number of other poor health conditions										
0			2,448	1.8	1.00	Referent				
1			1,453	5.5	3.49	2.39–5.10				
2			929	7.4	4.96	3.35–7.34				
3			501	6.8	4.67	2.93–7.43				
4–5			405	12.6	10.01	6.52–15.36				
6 or more			171	24.6	24.28	15.10–39.02				
					$P < 0.0001$ for trend					

* Variables were selected by a stepwise procedure with $P < 0.05$ for entry and removal; age was forced to enter into the model (OR for age was not shown)

checkup. Based on the information obtained during the interview, the author classified their headaches according to the International Classification of Headache Disorders, 2nd edn (ICHD-II) [7]. Migraine was diagnosed in 67% of them, tension-type headache in 20%, migraine with tension-type headache in 11%, and unspecified in 3%. The proportion of the subjects of this study who reported headaches was 5.4% of men and 15.4% of women. Large Japanese population-based studies have reported migraine headaches in 2.3–3.6% of men and 9.1–12.9% of women [8, 9], and the distribution of the subjects with headaches according to age in the present study was similar to that of

Table 4 Relationship between headaches and other poor health conditions in women

	Women									
	Other poor health conditions				Age-adjusted model			Multivariate model*		
	Absent		Present							
	N	Proportion of headache sufferers (%)	*N*	Proportion of headache sufferers (%)	OR	95%CI	*P*	OR	95%CI	*P*
Other poor health conditions										
Poor appetite	7,004	15.1	72	25.0	1.75	1.02–3.00	0.0416			
Weight loss	6,870	15.1	206	17.0	1.20	0.83–1.74	0.3370			
Feeling of food sticking in the throat	6,926	14.9	150	29.3	2.47	1.72–3.54	<0.0001			
Upper abdominal pain	6,920	14.7	157	36.3	3.37	2.41–4.70	<0.0001	1.66	1.13–2.43	0.0097
Lower abdominal pain	6,801	14.5	276	32.3	2.68	2.06–3.48	<0.0001	1.35	1.00–1.83	0.0470
Easy fatigability	5,643	11.7	1,441	29.4	3.05	2.65–3.52	<0.0001	1.73	1.47–2.04	<0.0001
Heartburn	6,784	14.6	292	29.8	2.85	2.18–3.71	<0.0001	1.38	1.01–1.89	0.0437
Heavy feeling in the stomach	6,454	13.8	628	30.6	2.80	2.33–3.37	<0.0001	1.54	1.24–1.92	<0.0001
Chest tightness	6,836	14.5	240	35.4	3.41	2.59–4.49	<0.0001	1.56	1.14–2.15	0.0062
Lower back pain	5,344	12.1	1,740	25.1	2.52	2.20–2.89	<0.0001	1.70	1.47–1.98	<0.0001
Numbness	6,542	14.4	541	25.7	2.29	1.86–2.82	<0.0001			
Palpitations/shortness of breath	6,607	14.0	472	32.8	3.30	2.68–4.06	<0.0001	1.48	1.16–1.88	0.0014
Edema	6,273	13.8	808	26.5	2.19	1.84–2.60	<0.0001	1.31	1.08–1.59	0.0061
Tremor	7,007	15.0	69	34.8	3.03	1.83–5.01	<0.0001			
Loss of energy	7,015	15.0	61	32.8	3.01	1.75–5.17	<0.0001			
Limb pain	6,698	14.7	380	24.7	2.23	1.74–2.86	<0.0001			
Dizziness	6,365	12.9	713	36.2	3.89	3.28–4.61	<0.0001	2.08	1.71–2.52	<0.0001
Cough/sputum	6,598	15.0	479	18.2	1.34	1.05–1.70	0.0197			
Bloody sputum	7,067	15.2	9	22.2	1.79	0.37–8.68	0.4713			
Nausea/vomiting	6,964	14.7	113	47.8	5.11	3.51–7.45	<0.0001	2.16	1.41–3.30	0.0004
Ringing in the ears	6,446	13.7	632	30.4	3.05	2.53–3.68	<0.0001	1.66	1.34–2.05	<0.0001
Bloody stools	7,028	15.1	49	26.5	2.06	1.08–3.91	0.0273			
Urination during the night	6,868	14.8	209	29.2	2.88	2.10–3.94	<0.0001	1.76	1.25–2.49	0.0014
Anxiety	6,083	13.6	997	25.4	2.15	1.83–2.53	<0.0001	1.21	1.01–1.46	0.0411
Sleep disturbance	6,350	14.0	730	25.6	2.25	1.87–2.70	<0.0001	1.29	1.05–1.58	0.0165
Number of other poor health conditions										
0			2,494	5.3	1.00	Referent				
1			1,813	13.5	2.87	2.29–3.58				
2			1,085	18.1	4.10	3.24–5.18				
3			709	20.7	4.83	3.75–6.23				
4–5			637	30.9	8.72	6.82–11.15				
6 or more			338	47.0	17.71	13.37–23.45				
					$P < 0.0001$ for trend					

* Variables were selected by a stepwise procedure with $P < 0.05$ for entry and removal; age was forced to enter into the model (OR for age was not shown)

the subjects who had migraine in these studies. Although we did not ask the time frame of the headache, these findings suggest that chronic headache sufferers tended to report that the item "I have headaches" applied to them and that a high proportion of the headache sufferers in our study had migraine. The subjects in this study consisted of workers or residents of Tokyo or neighboring areas, who had received an annual health checkup and who were more likely to be middle-aged women, probably in the middle-to-high socioeconomic bracket. These background factors at least partially explain the somewhat high headache prevalence in the subject population.

We confirmed that stress is a major precipitating factor of headaches, a finding consistent with the results of

Table 5 Multivariate analysis of risk factors for headache

	Men		Women	
	Multivariate OR*	95%CI	Multivariate OR*	95%CI
Age (year)				
20–29	1.00	Referent	1.00	Referent
30–39	0.63	0.39–1.01	0.63	0.39–1.01
40–49	0.42	0.26–0.67	0.42	0.26–0.67
50–59	0.31	0.19–0.49	0.31	0.19–0.49
60–69	0.19	0.10–0.35	0.19	0.10–0.35
70–79	0.36	0.08–1.60	0.36	0.08–1.60
	$P < 0.0001$		$P < 0.0001$	
Stress				
Very high	3.71	1.28–10.77	1.75	0.94–3.25
Somewhat high	2.41	0.86–6.72	2.23	1.24–4.03
Average	1.70	0.62–4.68	1.66	0.93–2.97
Low	1.81	0.62–5.34	1.42	0.75–2.69
Little or none	1.00	Referent	1.00	Referent
	$P = 0.0010$		$P = 0.0003$	
Number of other poor health conditions				
0	1.00	Referent	1.00	Referent
1	3.32	2.27–4.86	2.74	2.19–3.43
2	4.23	2.83–6.32	3.85	3.03–4.88
3	4.07	2.53–6.54	4.50	3.47–5.82
4–5	7.82	5.00–12.24	7.87	6.11–10.14
6 or more	17.68	10.66–29.34	15.78	11.75–21.18
	$P < 0.0001$		$P < 0.0001$	
Alcohol drinking				
Non-drinker	1.00	Referent	1.00	Referent
Less than 1 unit/day	0.80	0.60–1.08	0.79	0.67–0.93
1 to less than 2 units/day	0.61	0.43–0.87	0.69	0.53–0.91
2 to less than 3 units/day	0.59	0.39–0.91	0.37	0.20–0.68
3 units/day or more	0.40	0.25–0.63	0.50	0.26–0.96
	$P = 0.0004$		$P < 0.0001$	

* Variables except age were selected by a stepwise procedure with $P < 0.05$ for entry and removal

P values are for homogeneity among the subcategories of each factor

previous cross-sectional studies [10, 11] and a recent prospective study [12]. The present study also demonstrated a stepwise inverse relationship with ability to relieve stress as well as a positive association with stress level in both men and women. The two self-estimated aspects of stress had the greatest impact of all of the factors associated with having headaches in this study. Although in contrast to other quantifiable variables, self-estimated classification of stress may differ between men and women, the association between stress and headache was stronger in men than in women.

Previous studies have shown an association between the occurrence of headaches and the presence of pain elsewhere in the body [3, 4]. The present study demonstrated that headache sufferers not only tended to complain of other pain, but to report a variety of poor health conditions, and that having headaches was clearly associated with the number of poor health conditions in a stepwise fashion in both men and women. Increasing numbers of other painful areas [4] and combinations of chronic musculoskeletal complaints, gastrointestinal complaints, and psychiatric symptoms [13] have been reported to have a greater impact on the likelihood of headache occurrence. Whether the association is causal or the poor health conditions and headache share common background factors are topics for future research. However, since the comorbid conditions were all self-reported in a questionnaire, some of the strong associations between headache and poor health conditions may have been partly influenced by a tendency to answer all questions regarding complaints in a similar way

("reporting bias") [13]. Further study is needed to clarify the associations by assessing the comorbid conditions in a more objective way.

The present study demonstrated an inverse dose–response relationship between headaches and alcohol consumption in both men and women. Previous data for the association have been less clear [4, 9–11, 14, 15], but a large population-based cross-sectional study in Norway showed a tendency for the prevalence of headache to decrease with increasing alcohol consumption [16], and another large population-based cross-sectional study in the Netherlands showed that migraine sufferers were less likely to consume alcohol [17]. A recent prospective analysis of migraine sufferers in Austria showed that consumption of beer reduced the risk of headache and migraine, as well as the risk of headache persistence [12]. Our findings are consistent with the results of these studies. In the Norwegian study only 3% of the subjects reported drinking >14 standard units of alcohol per 2 weeks, whereas in our study 48% of the men and 12% of the women reported drinking ≥22 g ethanol per day. The drinking behavior of the Japanese is strongly governed by the Asian genetic polymorphism of ALDH2. ALDH2 genotyping among a subgroup of the present study population showed a much higher frequency of ALDH2-deficient individuals among the non/rare drinkers than the drinkers (75 vs. 33% of the men and 57 vs. 20% of the women). ALDH2-deficient individuals are more sensitive to alcohol flushing responses [18] and hangover [5, 6], in both of which headache is a major symptom. Intake of alcoholic beverages has been reported to be an aggravating factor of headache [4], especially migraine [19] and cluster headache [20]. Individuals with migraine have a higher risk of delayed alcohol-induced headache than those without it [21]. Possible mechanisms by which alcohol induces headache [22, 23] include a vasodilatory effect on the intracranial vasculature, altered cytokine pathways [24], endocrine and immune system disturbance, toxic effects of congeners, and acetaldehyde-mediated changes [5, 6, 18]. Japanese headache sufferers with inactive ALDH2 may be more vulnerable to severe alcohol-induced or hangover headache, than those without inactive ALDH2, and must avoid alcohol drinking. Another possible explanation of the inverse association between headache and alcohol drinking is related to the development of tolerance for headache in drinkers. Habitual drinking leads to the development of tolerance for alcohol-induced headache [6], which may affect the mechanisms by which common headaches occur. Third, non-drinking may influence other lifestyle factors associated with headache, since alcoholic beverages serve as a stress reliever or sleep aid in some persons. Further in-depth study of the association between headache classification and drinking habit is needed.

Furthermore, possible interactions between the ALDH2 genotype, alcohol consumption, and headache prevalence in Japanese subjects may differ according to the headache classification. We have developed a screening test for inactive ALDH2 that consists of the following two questions about current and past facial flushing: (1) Do you have a tendency to flush in the face immediately after drinking a glass (approximately 180 ml) of beer? (2) Did you have a tendency to flush in the face immediately after drinking a glass of beer during the 1st to 2nd year after you started drinking? When current or former flushing individuals were assumed to have inactive ALDH2, both the sensitivity and specificity of the test were approximately 90% among both Japanese men and women 40 years of age or more [25]. We are now conducting a large cross-sectional study in Tokyo workers by using the simple flushing questionnaire, a drinking questionnaire, and a headache questionnaire designed to diagnose headache type according to the ICHD-II criteria.

An inverse association between headaches and walking/exercise was observed in the present study, and the strength of association was somewhat greater in men than in women and was most prominent among the subjects who reported a walking/exercise frequency of "2 days/week". A study conducted in Denmark reported a significant association between low physical activity and tension-type headache in men, but not in women or in subjects with migraine [10]. Physical activity influences several factors, including stress, stress release, muscle strength, and prostaglandin and hormone levels [26], and further epidemiological and mechanistic studies are required. In our study, both less sleep and excessive sleep in men and less sleep in women were positively associated with having headaches, findings consistent with those of previous studies [27, 28].

In conclusion, although women were more susceptible to headache, Japanese men and women in Tokyo shared factors associated with headache, including age, stress, having other poor health conditions, alcohol consumption, sleep, and exercise.

Conflict of interest None.

References

1. Pryse-Phillips W, Findlay H, Tugwell P et al (1992) A Canadian population survey on the clinical, epidemiologic and societal impact of migraine and tension-type headache. Can J Neurol Sci 19:333–339
2. Vicente-Herrero T, Burke TA, Lainez MJA (2004) The impact of a worksite migraine intervention program on work productivity, productivity costs, and non-workplace impairment among Spanish postal service employees from an employer perspective. Curr Med Res Opin 20:1805–1814

3. Hagen K, Einarsen C, Zwart JA et al (2002) The co-occurrence of headache and musculoskeletal symptoms amongst 51,050 adults in Norway. Eur J Neurol 9:527–533
4. Boardman HF, Thomas E, Millson DS et al (2005) Psycological, sleep, lifestyle, and comorbid associations with headache. Headache 45:657–669
5. Yokoyama M, Yokoyama A, Yokoyama T et al (2005) Hangover susceptibility in relation to aldehyde dehydrogenase-2 genotype, alcohol flushing, and mean corpuscular volume in Japanese workers. Alcohol Clin Exp Res 29:1165–1171
6. Yokoyama M, Yokoyama A, Yokoyama T et al (2005) Hangover headache in Japanese male workers. Cephalalgia 25:988 (abstract)
7. Headache Classification Subcommittee of the International Headache Society (2004) International classification of headache disorders, 2nd edn. Cephalalgia 24 (Suppl 1): 8–152
8. Sakai F, Igarashi H (1997) Prevalence of migraine in Japan: a nationwide survey. Cephalalgia 17:15–22
9. Takeshima T, Ishizaki K, Fukuhara Y et al (2004) Population-based door-to-door survey of migraine in Japanese: the Daisen study. Headache 44:8–19
10. Spierings ELH, Ranke AH, Honkoop PC (2001) Precipitating and aggravating factors of migraine versus tension-type headache. Headache 41:554–558
11. Rasmussen BK (1993) Migraine and tension-type headache in a general population: precipitating factors, female hormones, sleep pattern and relation to lifestyle. Pain 53:65–72
12. Wöber C, Brannath W, Schmidt K et al (2007) Prospective analysis of factors related to migraine attacks: the PAMINA study. Cephalalgia 27:304–314
13. Hagen K, Stovner LJ, Zwart JA (2007) Potential and pitfalls in analytical headache epidemiological studies: lessons to be learned from the Head-HUNT study. Cephalalgia 27:403–413
14. D'Alessandro R, Benassi G, Lenzi PL et al (1988) Epidemiology of headache in the Republic of San Marino. J Neurol Neurosurg Psychiatry 51:21–27
15. Ulrich V, Olesen J, Gervil M et al (2000) Possible risk factors and precipitants for migraine with aura in discordant twin-pairs: a population-based study. Cephalalgia 20:821–825
16. Aamodt AH, Stovner LJ, Hagen K et al (2006) Headache prevalence related to smoking and alcohol use: the Head-HUNT study. Eur J Neurol 13:1233–1238
17. Scher AI, Terwindt GM, Picavet HSJ et al (2005) Cardiovascular risk factors and migraine: the GEM population-based study. Neurology 64:614–620
18. Muramatsu T, Higuchi S, Shigemori K et al (1989) Ethanol patch test: a simple and sensitive method for identifying ALDH phenotype. Alcohol Clin Exp Res 13:229–231
19. Van den Bergh V, Amery WK, Waelkens J (1987) Trigger factors in migraine: a study conducted by the Belgian Migraine Society. Headache 27:191–196
20. Schrks M, Kurth T, Knorn P et al (2006) Predictors of hazardous alcohol consumption among patients with cluster headache. Cephalalgia 26:623–627
21. Kuster GW, da Silva AL, Aquino CH et al (2006) Frequency and features of delayed alcohol-induced headache among university students. Headache 46:688–691
22. Evans RW, Sun C, Lay C (2007) Alcohol hangover headache. Headache 47:277–279
23. Wiese JG, Shlipak MG, Browner WS (2000) The alcohol hangover. Ann Int Med 132:897–902
24. Kaivola S, Parantainen J, Osterman T et al (1983) Hangover headache and prostaglandins: prophylactic treatment with tolfenamic acid. Cephalalgia 13:175–180
25. Yokoyama A, Kato H, Yokoyama T et al (2006) Esophageal squamous cell carcinoma and aldehyde dehydrogenase-2 genotypes in Japanese females. Alcohol Clin Exp Res 30:491–500
26. McTiernan A (2003) Intervention studies in exercise and cancer prevention. Med Sci Sports Exerc 35:1841–1845
27. Paiva T, Batista A, Martins P et al (1995) The relationship between headaches and sleep disturbances. Headache 35:590–596
28. Kelman L, Rains JC (2004) Headache and sleep: examination of sleep patterns and complaints in a large clinical sample of migraineurs. Headache 45:904–910