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Relationship between insomnia and headache in community-based middle-aged Hong Kong Chinese women

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Abstract Limited studies have investigated the prevalence of insomnia symptoms among individuals with different headache diagnoses and the association between insomnia and headache in subjects with comorbid anxiety and depression. A total of 310 community-dwelling Hong Kong Chinese women aged 40–60 years completed a self-administered questionnaire on headache, sleep difficulties, mood disturbances, and functional impairment. About 31% of the sample complained of recurrent headache unrelated to influenza and the common cold in the past 12 months. The percentages of women diagnosed to have migraine, tension-type headache (TTH), and headache unspecified were 8.4, 15.5 and 7.1%, respectively. The most frequent insomnia complaint was "problem waking up too early" (29.4%), followed by "difficulty staying asleep" (28.0%) and "difficulty falling asleep" (24.4%). Women with headaches were significantly more likely to report insomnia symptoms than those without headaches. There were no significant differences among women with migraine, TTH, and headache unspecified in the prevalence of insomnia symptoms. Logistic regression analysis showed that women with insomnia disorder as defined by an insomnia severity index total score ≥8 had 2.2-fold increased risk of reporting recurrent headache, 3.2-fold increased risk of migraine, and 2.3-fold increased risk of TTH, after adjusting for anxiety and depression. Individual insomnia symptoms were not independent predictors. The association between insomnia and headache was stronger in subjects with more frequent headaches. Our findings suggest that insomnia and the associated distress, but not insomnia symptoms alone, is an independent risk factor for recurrent headache in middle-aged women with mixed anxiety, depression and sleep disturbances.

Introduction

Headache is a common neurological symptom experienced by almost everyone. A recent review showed that the percentages of the adult population with an active headache disorder are 46% for headache in general, 11% for migraine, 42% for tension-type headache (TTH), and 3% for chronic daily headache [1]. A study in Hong Kong found that 37% of an adult sample was affected by recurrent headache; while the 1-year prevalence of migraine, TTH, and other headache diagnoses was 5, 27, and 6%, respectively [2]. Headache is associated with various medical and psychiatric conditions, such as anxiety and depression [3–6]. The burden of headache on the patient, their families, and on society is considerable [7].

An association between sleep disturbances and headache has been demonstrated in previous clinical and community studies [8–12]. Individuals with headaches report a host of sleep disturbances, such as insomnia, nightmares, nonrestorative sleep, and other complaints. Insomnia symptoms are notably common in headache sufferers. It was found that difficulty falling asleep affected as many as 50% of subjects with migraine [9, 13]. However, limited studies have investigated the prevalence of insomnia symptoms among individuals with headaches other than migraine. Rasmussen [11] reported that sleep problems, such as difficulty falling asleep, repeated wakening during the night,

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early morning awakening, restless sleep, or use of sleeping medicine were more prevalent in subjects with TTH than in migraineurs.

The high comorbidity of headache with anxiety and depression complicates the finding of the association between sleep disturbances and headache. Some recent studies investigated the relationship between headache, sleep disturbances, and comorbid anxiety and depression. Ohayon [14] conducted a cross-sectional telephone survey of 18,980 individuals across five European countries. The study showed that subjects with a diagnosis of DSM-IV insomnia disorder had an approximately twofold increase in the risk of having chronic morning headache after adjusting for all risk factors. A postal survey of 2,662 adults in UK found that the occurrence of headaches of all types in the previous 3 months was associated with anxiety and insomnia symptoms, but not with depressive symptoms [8]. The authors also found that the association between insomnia and headache was stronger in subjects with more severe and frequent headaches. In another study, Vgontzas et al. [13] found that adults with migraine had more complaints of inadequate sleep, difficulty falling asleep, difficulty staying asleep, and other sleep problems than those without migraine after adjustment for current anxiety and depressive disorders. The one prospective study carried out to date [15] confirmed an association between sleep problems and poorer outcome for TTH but not migraine. Negative prognostic indicators for TTH included fewer hours of sleep, waking nonrefreshed, and fatigue [16].

There is strong evidence that women have more insomnia symptoms [17, 18], depressive and anxiety disorders [19, 20], and headaches [1, 2, 14, 21] than men. Furthermore, perimenopausal and postmenopausal women, compared with premenopausal women, are significantly more likely to report sleep and mood disturbances [22, 23]. Studies have shown that headaches become worse at menopause but improve after menopause [24, 25].

Although the evidence suggests that the relationship between sleep disturbances and headache is independent of anxiety and depression [8, 13, 14], limited studies have investigated the association for non-migraine headaches and in women undergoing menopausal transition. Moreover, none of the studies have compared the prevalence of insomnia symptoms among individuals with different headache diagnoses. The aim of this study was to examine the relationship between insomnia symptoms, anxiety, depression, and recurrent headache of all types in a community sample of Chinese middle-aged women. Our hypotheses were that insomnia problem was independently associated with the report of recurrent headache, and that the association between insomnia and headache was stronger in subjects with more frequent headaches.

Methods

Subjects

We recruited our subjects at community centers and women's clubs in Hong Kong. The centers and clubs offer interest groups and vocational training courses for the general public. Out of 39 centers we have conveniently selected, 10 agreed to participate in this study. The inclusion criteria of this study were: (1) ethnic Chinese women; (2) aged 40–60 years; and (3) able to complete the questionnaires without assistance. Women aged 40–60 years were recruited because women undergo menopausal transition in this period. The study was reviewed and approved by the local institutional review board.

Procedures

The author (C.Y.W.) approached the subjects after their group meetings or classes and explained the aim of the study to potential participants. The subjects completed a self-administered questionnaire that examined their sleep, anxiety, depression, recurrent headache, and level of functioning. They were also asked to report their sociodemographic information, use of oral contraceptives and hormone replacement therapy, and history of surgical removal of ovaries. Written informed consent was obtained from all participants.

Menopausal status was assessed by self-reported menstrual history. The criteria for natural postmenopausal status were reported amenorrhea for 12 consecutive months and not taking hormone therapy. Women who had missed cycling between 3 and 11 consecutive months were classified as perimenopausal and those not having missed cycling for 3 consecutive months were considered premenopausal.

Measures

We used the insomnia severity index (ISI) [26] to assess the severity of insomnia symptoms and the associated functional impairment in the recent 2 weeks. Previous studies have shown that the ISI is a reliable and valid instrument to evaluate the severity of insomnia [26, 27]. Insomnia symptoms were reported using three items: "difficulty falling asleep"; "difficulty staying asleep"; and "problem waking up too early". The subjects checked one of the five responses (0 = none; 1 = mild; 2 = moderate; 3 = severe; and 4 = very). There are four items assessing satisfaction with current sleep pattern, interference with daily functioning, noticeability of impairment attributed to the sleep problem, and degree of distress or concern caused

by the sleep problem. Each functional impairment item is rated on a 5-point Likert scale.

We also examined the insomnia complaints according to the DSM-IV diagnostic criteria [28]. Insomnia disorder was present if the subjects complained of difficulty initiating or maintaining sleep, or non-restorative sleep for at least three times per week in the past 1 month that lead to significant distress or impairment in daytime functioning. The severity of snoring was assessed by a single item about the frequency of snoring.

The hospital anxiety and depression scale (HADS) [29] was used to assess the levels of anxiety and depression in the previous week. The HADS contains seven items on anxiety and seven items on depression; a higher score indicates greater severity. Since the HADS does not contain items on somatic symptoms, the presence of headache and insomnia will not affect the validity of anxiety and depression.

We used a 20-item self-reported questionnaire to assess headache characteristics: frequency, duration, intensity, quality, location of pain, associated features, and precipitating and aggravating factors [2]. We also assessed the influence of menstruation, oral contraceptives, hormone replacement therapy, and pregnancy to the severity and frequency of headache. Recurrent headache was defined as having two or more headaches unrelated to influenza or the common cold in the previous 12 months. Women who reported their headaches invariably caused by influenza or the common cold were classified as headache-free subjects. Based on the information from the questionnaire, headache disorders were classified according to the international classification of headache disorders, second edition (ICHD-II) criteria [30]. Headache frequency was categorized into headaches occurring less than weekly and those occurring at least once a week.

The Sheehan disability scale (SDS) [31] was used to assess the degree of disability on work, social life, and family life due to headaches; a higher score indicates more severe impairment.

All questionnaires were presented in Chinese. We used the Chinese version of the HADS, which is known to be reliable and valid [32]. The original English versions of the ISI and SDS were translated into Chinese by a bilingual translator. The items and response choices were back-translated into English by another researcher who was blinded to the original version. The back-translation was compared with the original English version and modified until consensus between the investigators was achieved.

Statistical analysis

All statistical analyses were performed by SPSS 17.0 for Windows (SPSS Inc, Chicago, IL). Relationship between headache occurrence and headache diagnoses and sociodemographic characteristics, insomnia problem, and anxiety and depressive symptoms was analyzed using chi-square test for categorical variables and unpaired t test or one-way analysis of variance (ANOVA) for continuous variables. Logistic regression analysis was used to assess the simultaneous influence of different variables on the risk of having migraine, TTH, headache unspecified, and all types of headaches. Further analyses were conducted to compare respondents in each headache frequency category with those not reporting headache. Similar logistic regression analysis was used to determine if the association between headache and insomnia was stronger in subjects with more frequent headaches. Responses of "moderate", "severe' and "very" for the ISI symptom items were considered presence of an insomnia symptom. Subjects were categorized to have insomnia disorder on the basis of ISI total score ≥ 8, a cutoff for sleep difficulties in previous studies [26, 33].

Results

Subjects

A total of 445 copies of questionnaires were distributed to eligible subjects, of whom, 351 (78.9%) were returned. Of the 351 returned questionnaires, 35 of them were excluded due to grossly incomplete data, and 6 were excluded due to participants' pregnancy. Hence, 310 (69.7%) subjects were included in the final analysis. We had no information of the subjects who did not return their questionnaires. Table 1 presents the participants' sociodemographic data. The mean age of the women was 49.0 years. A high proportion of the sample ($N = 270$, 87.9%) was married or cohabiting. About two-third of the women were homemakers or unemployed ($N = 198$, 65.6%). We compared the social and educational background of our subjects with that of general population of similar age group. There was a slightly lower proportion of women with higher education and a higher proportion of homemakers and unemployed women in the survey population. One hundred and seventy-seven women (57.5%) were premenopausal, 124 women (40.3%) were postmenopausal, but only 7 (2.3%) were perimenopausal. Only 19 women (6.1%) were taking oral contraceptives or hormone replacement therapy.

Prevalence of headaches

One hundred and seventy-four subjects (56.1%) reported having two or more headaches in the previous year; of which, 96 women (31.0%) reported recurrent headache unrelated to influenza or the common cold. According to

Table 1 Sociodemographic characteristics by headache occurrence

Variables	Total (N = 310)	HK women aged 40–60 years (N = 1,179,236)[a]	With headache (N = 96)	Without headache (N = 214)	Chi square/ t value[b]	P value
Age in year, mean (SD, range)	49.0 (5.5, 40–60)	48.3	49.3 (5.5, 40–60)	48.9 (5.5, 40–60)	0.70	0.49
Ninth grade education or above (N, %) (N = 284)[c]	140 (49.3)	710,468 (60.2)	42 (48.3)	98 (49.7)	0.05	0.90
Martial status (N, %) (N = 307)[c]					0.50	0.77
Married/cohabitating	270 (87.9)	899,613 (76.3)	86 (89.6)	184 (87.2)		
Never married	17 (5.5)	134,525 (11.4)	4 (4.2)	13 (6.2)		
Divorced/widowed	20 (6.5)	145,098 (12.3)	6 (6.3)	14 (6.6)		
Occupation (N, %) (N = 302)[c]					1.10	0.89
Professional and associate professional	22 (7.3)	155,823 (13.2)	7 (7.5)	15 (7.2)		
Skilled and semi-skilled worker	45 (14.9)	276,241 (23.4)	11 (11.8)	34 (16.3)		
Unskilled worker	21 (7.0)	199,009 (16.9)	6 (6.5)	15 (7.2)		
Retired	12 (5.3)	72,860 (6.2)	5 (5.4)	11 (5.3)		
Unemployed/housework	198 (65.6)	475,303 (40.3)	64 (68.8)	134 (64.1)		
Monthly family income in HK$ (N, %) (N = 294)[c]					0.00	1.00
<15,000	122 (41.5)	1,044,131 (40.5)[d]	38 (41.3)	84 (41.6)		
≥15,000	172 (58.5)	1,532,009 (59.5)	54 (58.7)	118 (58.4)		

[a] Population census 2006

[b] Comparing subjects with and without headaches by chi-square or unpaired t test

[c] Difference from total N reflects omissions on reporting forms

[d] Based on the whole HK population

the ICHD-II criteria, the diagnosis of migraine without aura (1.1) was obtained in 5 women (5.2% of the headache disorders), migraine with aura (1.2) in 1 subject (1.0%), and probable migraine (1.6) in 20 respondents (20.8%). Infrequent episodic TTH (1.1), frequent episodic TTH (2.2), chronic TTH (2.3) and probable TTH (2.4) were diagnosed in 10 (10.4%), 10 (10.4%), 1 (1.0%) and 27 (28.1%) subjects, respectively. Moreover, 22 women (22.9%) received the diagnosis of headache unspecified (14.2).

Fifty-seven of 93 subjects (61.3%) who responded to the question on pain intensity described the headaches as "moderate", "severe" or "very severe" in the past month. Twenty-two of the 84 participants (26.2%) who reported headache frequency had at least one headache a week, while 62 women (73.8%) had headaches less than weekly. Twenty of the 56 women (35.7%) who responded the questions on hormonal influence on headache frequency said that headache was more frequent during menstruation but unrelated to the use of oral contraceptives, hormone replacement therapy and pregnancy.

There was no significant difference in age, educational level, marital status, occupation and family income between subjects with and without headaches (Table 1). The prevalence of recurrent headache in premenopausal,

perimenopausal and postmenopausal women was 30.5, 14.3 and 33.1%, respectively; for women taking oral contraceptives or hormone replacement therapy and those with history of complete oophorectomy, the prevalence was 31.6 and 29.2%, respectively. We found that recurrent headache was not significantly associated with menopausal stage ($\chi^2 = 1.2$, $P = 0.56$). The use of oral contraceptives or hormone replacement therapy and the history of complete oophorectomy were not associated with recurrent headache ($\chi^2 = 0.004$, $P = 0.95$, and $\chi^2 = 0.04$, $P = 0.84$, respectively).

Prevalence of insomnia, anxiety and depression

The most frequent insomnia complaint in the previous 2 weeks according to the ISI responses was "problem waking up too early" with 86 women (29.4%) having moderate, severe or very severe problems (Table 2), followed by "difficulty staying asleep" ($N = 82$, 28.0%) and "difficulty falling asleep" ($N = 73$, 24.4%). About 9.8% of the subjects reported difficulty initiating or maintaining sleep, or non-restorative sleep for more than three times per week in the previous month that caused significant distress or impairment in functioning. The mean total ISI score was 7.1 (SD = 5.5, range = 0–25). Snoring for at least three

nights per week was reported in 31 women (13.8%). The average HADS anxiety subscore was 5.6 (SD = 3.5; range = 0–20); for HADS depression, the average subscore was 4.6 (SD = 3.2; range = 0–19). Eighty-six women (28.1%) had HADS anxiety subscore ≥8, indicating possible anxiety problem; while 56 subjects (18.6%) had possible depression.

Subjects with headaches were significantly more likely to report insomnia symptoms than those without headaches (Table 2). The prevalence of DSM-IV insomnia disorder was also higher in women with headaches. The mean ISI total score, HADS anxiety subscore, and HADS depression subscore were significantly higher in subjects with headaches. Women with headaches also reported more frequent snoring, but the difference was marginally non-significant ($\chi^2 = 4.1$, $P = 0.056$). There were significantly more disruptions in work, social life and family life in women with headaches than those without headaches.

Table 2 presents the prevalence of insomnia, anxiety, and depression in subjects with different headache diagnoses. There was no significant difference among women with migraine, TTH, and headache unspecified in the prevalence of insomnia symptoms (χ^2 test, all $P > 0.05$). The mean ISI total score, HADS anxiety subscore, HADS depression subscore, and the associated disruptions in work, social life and family life by the SDS were not significantly different among subjects with different headache diagnoses (ANOVA, all $P > 0.05$).

Subjects with at least one headache per week had significantly higher ISI total score and HADS anxiety subscore than those with less frequent headache (Table 2). There were significantly more disruptions in work, social life and family life in women with more frequent headaches.

Relationship between insomnia symptoms and headaches

Odds ratios for having insomnia symptoms and high ISI score were significantly increased in headache sufferers than headache-free subjects (Table 3); however, only high ISI score (OR = 2.2, 95% CI = 1.2–4.0) was independently related to the occurrence of recurrent headache of all types in the previous year after adjusting for anxiety and depression.

Insomnia symptoms and high ISI score were associated with the occurrence of individual headache subtypes. Specifically, high ISI score was associated with migraine, all three insomnia symptoms and high ISI score were related to TTH, and difficulty maintaining sleep was associated with headache unspecified (Table 3). After adjustment for anxiety and depression, only high ISI score was independently related to the occurrence of migraine

and TTH. Subjects with an ISI total score ≥8 had an approximately 3.2-fold increased risk of migraine and 2.3-fold increased risk of TTH. The significant association between insomnia symptoms and individual headache subtypes disappeared after taking into account of anxiety and depression. In addition, neither insomnia symptoms nor high ISI score was associated with headache unspecified after adjusting for anxiety and depression.

The associations between insomnia and headache were stronger in subjects with at least one headache a week than those with less frequent headaches (Table 3). After adjustment for anxiety and depression, subjects with an ISI total score ≥8 had a 4.0-fold increased risk of having at least one headache a week and 2.0-fold increased risk of having headache less than weekly. The problem of waking up too early was significantly more common in both headache frequency groups; however, after adjustment for anxiety and depression, only the less frequent headache group was significantly associated with the insomnia symptom.

Discussion

The findings supported our hypotheses that insomnia was an independent predictor of recurrent headache, and that headache of greater frequency was more strongly associated with insomnia. After controlling for the severity of anxiety and depression, headache occurring at least once per week had the strongest association with insomnia. Specifically, women with insomnia disorder as defined by an ISI total score ≥8 had an approximately 4.0-fold increased risk of having headache at least one a week, 3.2-fold increased risk of migraine, 2.3-fold increased risk of TTH, and 2.2-fold increased risk of headache of all types.

About 31% of the participants complained of recurrent headache unrelated to influenza and the common cold in the past 12 months. The prevalence of recurrent headache in our sample was comparable to the result obtained in a recent local community-based telephone survey [2]. Previous studies observed that the prevalence of headaches peaks between 30 and 50 years, and then decreases with age [2, 6], and that headaches are associated with menopausal stage, with reduction in the prevalence and severity of headaches after menopause [34]. However, we were unable to detect any age difference between women with and without headaches or any significant difference in the prevalence of headache between premenopausal and postmenopausal women. Our findings agreed with the results of previous studies that recurrent headache was not associated with any occupational group or a particular level of education [2, 35].

Table 2 Clinical variables by headache occurrence, diagnoses and frequency

	Total (N = 310)	Headache occurrence and diagnoses						Headache frequency		
		Migraine (N = 26)	Tension-type headache (N = 48)	Headache unspecified (N = 22)	All headaches (N = 96)	Without headache (N = 214)	Chi square/t value[a]	At least one per week (N = 22)	Less than one per week (N = 62)	Chi square/t value
Insomnia symptoms[b]										
Difficulty falling asleep (N, %) (N = 299)[c]	73 (24.4)	9 (34.6)	17 (35.4)	6 (28.6)	32 (33.7)	41 (20.1)	6.5*	11 (50.0)	18 (29.0)	3.2
Difficulty staying asleep (N, %) (N = 293)[c]	82 (28.0)	10 (38.5)	20 (41.7)	9 (42.9)	39 (41.1)	43 (21.7)	11.9**	12 (54.5)	23 (37.1)	2.0
Problem waking up too early (N, %) (N = 293)[c]	86 (29.4)	10 (40.0)	23 (47.9)	8 (38.1)	41 (43.6)	45 (22.6)	13.6***	12 (54.5)	26 (42.6)	0.9
DSM-IV insomnia disorder[d] (N, %) (N = 297)[c]	29 (9.8)	4 (16.0)	10 (21.7)	4 (20.0)	18 (19.8)	11 (5.3)	14.9***	5 (23.8)	10 (16.9)	0.5
ISI total score, mean (SD, range) (N = 282)[c]	7.1 (5.5, 0–25)	9.2 (4.6, 1–20)	10.0 (6.5, 0–25)	7.8 (6.6, 0–25)	9.3 (6.1, 0–25)	6.0 (4.8, 0–23)	4.8***	12.1 (6.1)	8.7 (5.8)	2.3*
Frequent snoring[e] (N, %) (N = 225)[c]	31 (13.8)	4 (25.0)	8 (25.0)	2 (10.5)	14 (20.9)	17 (10.8)	4.1	6 (33.3)	8 (19.5)	1.3
HADS										
Anxiety subscore, mean (SD, range) (N = 306)[c]	5.6 (3.5, 0–20)	7.1 (3.6, 0–17)	7.3 (4.3, 0–20)	6.0 (3.9, 0–13)	7.0 (4.0, 0–20)	5.0 (3.1, 0–13)	4.7**	9.7 (4.5)	6.2 (3.5)	3.7**
Depression subscore, mean (SD, range) (N = 301)[c]	4.6 (3.2, 0–19)	5.6 (3.0, 0–11)	6.0 (3.8, 1–19)	4.5 (3.7, 0–13)	5.5 (3.6, 0–19)	4.1 (3.0, 0–13)	3.6**	6.7 (4.0)	5.4 (3.6)	1.4
Sheehan Disability Scale										
Work subscore, mean (SD, range) (N = 282)[c]	0.7 (0.8, 0–4)	1.3 (0.9, 0–3)	1.0 (0.8, 0–3)	0.9 (1.0, 0–3)	1.0 (0.9, 0–3)	0.6 (0.7, 0–4)	4.3**	1.5 (0.9)	1.0 (0.9)	2.2*
Social life subscore, mean (SD, range) (N = 286)[c]	0.7 (0.8, 0–4)	1.3 (0.9, 0–3)	1.0 (0.8, 0–3)	0.8 (0.7, 0–2)	1.0 (0.8, 0–3)	0.6 (0.8, 0–4)	4.7**	1.5 (0.7)	1.0 (0.8)	2.2*
Family life subscore, mean (SD, range) (N = 285)[c]	0.8 (0.8, 0–4)	1.5 (0.9, 0–3)	1.1 (0.9, 0–3)	0.9 (0.7, 0–2)	1.2 (0.9, 0–3)	0.6 (0.7, 0–4)	5.5**	1.8 (0.8)	1.0 (0.8)	3.3**

HADS hospital anxiety and depression scale, *ISI* insomnia severity index

* $P < 0.05$; ** $P < 0.01$

[a] Comparing subjects with and without headaches by chi-square or unpaired t test

[b] Moderate, severe or very

[c] Difference from total N reflects omissions on reporting forms

[d] Self-report of difficulty initiating or maintaining sleep, or non-restorative sleep that caused significant distress or impairment in functioning and occurred ≥3 times/week in the past month

[e] Self-report of snoring ≥3 times/week

Table 3 Prevalence and odds ratios (OR) of insomnia symptoms for headache occurrence, diagnosis and frequency, as compared with no headache

	Difficulty falling asleep				Difficulty staying asleep				Problem waking up too early				ISI score ≥ 8			
	N	%	OR[a] (95% CI)	AOR[b] (95% CI)	N	%	OR[a] (95% CI)	AOR[b] (95% CI)	N	%	OR[a] (95% CI)	AOR[b] (95% CI)	N	%	OR[a] (95% CI)	AOR[b] (95% CI)
Headache-free (N = 214)	41	20.1	1.0	1.0	43	21.7	1.0	1.0	45	22.6	1.0	1.0	62	30.7	1.0	1.0
All headaches (N = 96)	32	33.7	2.0* (1.2–3.5)	1.4 (0.8–2.7)	39	41.1	2.5** (1.5–4.4)	1.7 (0.9–3.1)	41	43.6	2.7** (1.6–4.6)	1.8 (1.0–3.4)	53	57.0	3.0** (1.8–5.0)	2.2* (1.2–4.0)
Migraine (N = 26)	9	34.6	2.1 (0.8–5.1)	1.4 (0.5–4.0)	10	38.5	2.2 (0.9–5.3)	1.4 (0.5–3.9)	10	40.0	2.2 (0.9–5.4)	1.5 (0.5–4.0)	16	64.0	3.9** (1.6–9.4)	3.2* (1.2–8.6)
Tension–type headache (N = 48)	17	35.4	2.2* (1.1–4.4)	1.5 (0.7–3.3)	20	41.7	2.6** (1.3–5.1)	1.6 (0.7–3.4)	23	47.9	3.2* (1.6–6.2)	2.0 (0.9–4.5)	28	59.6	3.3** (1.7–6.4)	2.3* (1.1–5.0)
Headache unspecified (N = 22)	6	28.6	1.7 (0.6–4.5)	1.1 (0.3–3.6)	9	42.9	2.9* (1.1–7.3)	2.2 (0.7–6.7)	8	38.1	2.2 (0.9–5.7)	1.6 (0.5–5.0)	9	42.9	1.7 (0.7–4.3)	1.2 (0.4–3.6)
Headache at least one a week (N = 22)	11	50.0	3.6** (1.5–9.0)	2.1 (0.7–6.0)	12	54.5	3.9** (1.5–9.9)	1.7 (0.6–5.0)	12	54.5	3.7** (1.5–9.3)	1.4 (0.5–4.4)	17	77.3	7.4** (2.6–21.2)	4.0* (1.2–13.2)
Headache less than one a week (N = 62)	18	29.0	1.7 (0.9–3.2)	1.3 (0.6–2.7)	23	37.1	2.2* (1.2–4.1)	1.7 (0.8–3.4)	26	42.6	2.7** (1.4–5.0)	2.2* (1.1–4.5)	31	51.7	2.4** (1.3–4.4)	2.0* (1.0–4.0)

* $P < 0.05$; ** $P < 0.01$

[a] Odds ratios adjusted for age and menopausal status

[b] Odds ratios adjusted for age, menopausal status, anxiety and depression

Limited studies have compared the prevalence of insomnia symptoms among different headache subtypes. Rasmussen [11] reported that sleep problem was more prevalent in subjects with TTH than in migraineurs; however, our data showed that there was no significant difference in the prevalence of difficulty falling asleep, repeated wakening during the night and early morning awakening among sufferers of migraine, TTH, and other headache diagnoses. Replication of the findings in future studies of larger sample size is warranted.

Studies on the relationship between sleep, anxiety, depression, and headaches are relatively limited. Our findings confirmed the results of previous studies [8, 13] that insomnia was a risk factor for migraine and TTH, independent of age, menopausal status, anxiety, and depression. Also, we replicated the results of a postal survey in UK [8] that the association between insomnia and headache was stronger in subjects with more frequent headaches. We found that insomnia disorder as defined by an ISI total score ≥8, but not individual insomnia symptoms, was independently associated with recurrent headache after adjusting for anxiety and depression. This finding is consistent with a recent study that the distress associated with insomnia as captured by the ISI is more important in determining pain symptoms than insomnia symptoms alone [36]. Future studies of the relationship between sleep and headache should consider using a standardized assessment of sleep disturbance and insomnia [37].

An unexpected finding of our study was that after adjusting for anxiety and depression, problem waking up too early was associated only with the less frequent headache group. It was possible that the association between problem waking up too early and headache of greater frequency was largely attributed by anxiety and depression; when anxiety and depression were taken into consideration, the significant association was not detected.

There are several limitations in our study. The correlation analyses of this study restrict our ability to make causal inferences on the relationship between insomnia and headaches. Paiva and Hering-Hanit [38] have categorized six different potential relations between sleep and headache. Further studies using a micro-longitudinal design to examine the within-person and day-to-day changes in sleep and headache severity are warranted. The recruitment was not systematic and we had not obtained a precise account of the women refusing to participate. The sample was not randomly selected from the general population and had an over-representation of homemakers and unemployed women. Moreover, very few women in our survey population were in perimenopausal stage; hence, the prevalence of headache and sleep disturbances in perimenopausal women was likely

to be biased. Lastly, our self-report data could only reflect the women's subjective and retrospective experience on insomnia and headaches. Further prospective studies using objective sleep measures are needed to accurately determine the impact of sleep on headache.

Despite these limitations, our findings have important clinical implications. As headaches, sleep problem, anxiety and depression are common comorbidities, our data suggest that insomnia disorder is an independent risk factor for headache in middle-aged women. A recent pilot study found that augmenting usual medical care with behavioral sleep modification could alleviate headache frequency and intensity in women with transformed migraine [39]. Further studies are needed to examine whether treatment of sleep disturbances can reduce the severity of headache in other headache diagnoses.

Conflict of interest None.

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