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Different effects of migraine associated features on headache impact, pain intensity, and psychiatric conditions in patients with migraine

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Migraine is a multifactorial brain disorder characterized by recurrent disabling headaches and their associated features. Several studies have suggested that these features are related to headache impact, pain intensity, and psychiatric conditions. However, differences in the relationship between each associated feature and headache impact, pain intensity, or psychiatric conditions remain unclear. This study aimed to assess the impact of migraine-associated features on headache impact, pain intensity, and psychiatric conditions in patients with migraine. In this two-centered study, patients with migraine without aura (MwoA) were enrolled to exclude those without headaches and avoid the influence of medication overuse, which is commonly associated with chronic migraine. We used multiple logistic regression to analyze the headache impact, pain intensity, and psychiatric conditions measured using the Headache Impact Test (HIT-6), Visual Analog Scale (VAS), Generalized Anxiety Disorder 7-item scale (GAD-7), and Patient Health Questionnaire-9 (PHQ-9). Patients' likelihood of experiencing symptoms such as nausea, vomiting, photophobia, phonophobia, osmophobia, and allodynia were also recorded. A total of 1103 patients with MwoA were enrolled in this study, and 164 patients were excluded from the study because of missing data. Finally, 939 patients with MwoAs were included. On multiple logistic regression analyses, nausea (odd ratios [OR] 1.87, confidence interval [CI]: 1.37–2.54), vomiting (OR 1.57, CI: 1.11–2.23), photophobia (OR 1.67, CI: 1.18–2.35), and allodynia (OR 1.56, CI: 1.06–2.28) were independent positive predictors of higher HIT-6 scores, and nausea (OR 1.72, CI: 1.22–2.43), vomiting (OR 1.84, CI: 1.29–2.63), phonophobia (OR 1.58, CI: 1.10–2.25), photophobia (OR 1.49, CI: 1.07–2.08), and allodynia (OR 1.81, CI: 1.24–2.66) were independent positive predictors of higher VAS score. Nausea (OR 1.49, CI: 1.09–2.02), phonophobia (OR 2.00, CI: 1.42–2.82), and allodynia (OR 1.81, CI: 1.24–2.63) were independent positive predictors of GAD-7 score. Nausea (OR 1.66, CI: 1.21–2.28), phonophobia (OR 1.49, CI: 1.05–2.11), and allodynia (OR 1.68, CI: 1.16–2.45) were independent positive predictors and vomiting (OR 0.54, CI: 0.37–0.78) was an independent negative predictor of PHQ-9 score. Our results suggest that nausea, vomiting, photophobia, phonophobia, and osmophobia have distinct effects on headache impact, pain intensity, and psychiatric conditions. Understanding these differences can aid in the personalized management of patients with MwoA.

Keywords Migraine, Associated features, Disability, Psychiatric conditions, Allodynia

Abbreviations

ASC	Allodynia Symptom Checklist
HIT-6	Headache Impact Test
VAS	visual analog scale
GAD-7	Generalized Anxiety Disorder 7-item
PHQ-9	Patient Health Questionnaire-9

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OR	odds ratio
CI	confidence interval
BMI	body mass index

Migraine is a complex and disabling disorder primarily characterized by the presence of a prominent headache. However, owing to the diverse clinical manifestations observed in individuals with migraines, including nausea, vomiting, photophobia, phonophobia, and osmophobia, headache may not always be the primary or most prominent symptom of distress[1]. Research has shown that these secondary features may be associated with migraine-related psychiatric conditions[1–6]. However, the differential effects of each associated feature on migraine disability and psychiatric conditions have not been fully investigated.

Recently, Japanese researchers have shown growing awareness of the effects of headache disorders on the overall health of the Japanese population[7–14]. Related studies have revealed several consequences for people with migraines, including an unmet need for migraine healthcare, increased burden and disability, decreased quality of life, productivity impairment, and employer costs. However, differences in the impact of each associated feature on migraine disability or psychiatric conditions in Japan remain relatively understudied.

This study examined the differential effects of migraine-associated features on headache impact, pain intensity, and psychiatric comorbidities in patients with migraines without aura (MwoA). Previous studies have reported differing prevalences of associated features among patients with MwoA, migraine with aura, and chronic migraine[15,16]. Migraines with aura include migraines without headaches. Chronic migraines are often associated with headaches due to the overuse of medications. This study enrolled patients with MwoA, excluding those with migraine with aura and chronic migraine, owing to potential confounding factors (such as migraine aura without headache or medication overuse headache). Migraine-associated features include nausea, vomiting, photophobia, and phonophobia, which are listed in the ICHD-3 as accompanying migraine symptoms. We further included patients with osmophobia or allodynia. Osmophobia is a potentially useful diagnostic marker of migraines[17,18], while allodynia is thought to be a marker of central sensitization in patients with migraine[19,20].

Methods

Study design and setting

This two-center prospective investigation of patients with headache disorders was conducted at two accredited headache education facilities endorsed by the Japanese Headache Society: the Japanese Red Cross Shizuoka Hospital and the Sendai Headache and Neurology Clinic. All procedures and analyses were performed in accordance with the relevant guidelines and regulations. The participants provided informed consent in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects issued by the Japanese Ministry of Health, Labor, and Welfare. Informed consent was obtained from all participants and/or their legal guardians(s). This study was approved by the Ethics Committee of the Japanese Red Cross Shizuoka Hospital (reference number: 2018–21).

Participants

We conducted a prospective assessment of the clinical features of patients with headache disorders who sought care at two facilities between May 2019 and January 2020. Patients who did not provide consent for study participation or were ineligible for inclusion, as determined by the investigator, were excluded. Parental consent was also a prerequisite for the non-adult participants. Headache disorders were diagnosed by headache specialists accredited by the Japanese Headache Society, in accordance with the International Classification of Headache Disorders, 3rd edition[21]. Diagnostic evaluations, including magnetic resonance imaging, computed tomography, lumbar puncture, and relevant laboratory assessments, were performed when necessary.

Clinical assessments

Information on age; sex; family history of headache; smoking; alcohol consumption; body mass index (BMI); and associated features such as nausea, vomiting, photophobia, phonophobia, osmophobia, and allodynia were collected. Allodynia was assessed using the Allodynia Symptom Checklist (ASC)[22], and a score ≥ 3 was considered to indicate allodynia. The group with associated features was defined as the present group, whereas the group without associated features was defined as the absent group. We conducted a questionnaire survey to collect data using the Headache Impact Test (HIT-6)[23], visual analog scale (VAS), and psychiatric assessments, including the Japanese versions of the Generalized Anxiety Disorder 7-item scale (GAD-7)[24] and Patient Health Questionnaire-9 (PHQ-9)[25]. The GAD-7 and PHQ-9 are self-reporting questionnaires designed to assess the severity of generalized anxiety disorders and depressive symptoms, respectively.

Statistical analysis

We conducted a comparative analysis to assess the impact of associated features, including nausea, vomiting, photophobia, phonophobia, osmophobia, and allodynia, on the HIT-6, VAS, GAD-7, and PHQ-9 scores using the Mann-Whitney U test. Multiple logistic regression analyses were further conducted using the median-split HIT-6, VAS, GAD-7, and PHQ-9 scores as dependent variables; and nausea, vomiting, photophobia, phonophobia, osmophobia, and allodynia as independent variables. All statistical tests were two-sided, and significance was set at $p < 0.05$. The multivariate logistic regression model simultaneously evaluated multiple independent variables while analyzing the independent effects of each variable; p-value correction was therefore not performed. Statistical analyses were performed using the SPSS Statistics software (version 29.0; IBM Corp., Armonk, NY, USA).

Results

Study population

A total of 1103 patients with MwoA were enrolled in this study. There were no missing data on sex, age, nausea, vomiting, photophobia, phonophobia, or osmophobia. However, data for ASC, HIT-6, VAS, GAD-7, and PHQ-9 were missing in 1.5–7.3% of patients (Supplementary Table S1). Due to missing data on headache impact, pain intensity, and/or psychiatric condition scales, 164 patients were excluded. Finally, 939 patients with MwoA (mean age, 32.8 ± 13.9 years; 72% women) were evaluated in this study (Fig. 1).

No significant differences in age or sex were observed between the evaluated and excluded patients (Supplementary Table S2).

Characteristics of the study population

The characteristics of the study population are summarized in Table 1. The majority of the participants were women (72.3%), and their median age was 32.0 years. In terms of symptoms, a significant proportion (59.6%) of participants reported experiencing nausea, while 23.9% reported vomiting. Other common symptoms included phonophobia (27.1%), photophobia (32.6%), osmophobia (16.6%), and allodynia (17.1%). The health assessment showed that, on average, participants were moderately impacted by headaches, as indicated by a median HIT-6 score of 61.0 (interquartile range [IQR]: 56.0, 65.0). Pain intensity measured using the VAS showed a median score of 70.0 (IQR: 50.0, 80.0). Psychological assessments showed median scores for anxiety (GAD-7) and depression (PHQ-9) of 4.0 (IQR: 2.0, 8.0), suggesting a moderate level of psychological distress.

Relationship between associated features and headache impact, pain intensity, or psychiatric conditions

Table 2 shows the relationship between the associated features, including nausea, vomiting, photophobia, phonophobia, osmophobia, allodynia, headache impact, pain intensity, and psychiatric conditions, as assessed using the HIT-6, VAS, GAD-7, and PHQ-9. The HIT-6 and VAS scores for nausea, vomiting, phonophobia, photophobia, osmophobia, and allodynia were significantly higher in the present group than in the absent group ($p < 0.001$). Regarding the GAD-7 and PHQ-9, nausea, phonophobia, photophobia, osmophobia, and allodynia was significantly higher in the presence group than in the absence group ($p < 0.001$), whereas that of vomiting showed no significant difference ($p = 0.499$).

Table 3 shows the results of the multiple logistic regression analysis. The Hosmer-Lemeshow test yielded values of 0.121, 0.748, 0.737, and 0.464 for the HIT-6, VAS, GAD-7, and PHQ-9, respectively, while the corresponding

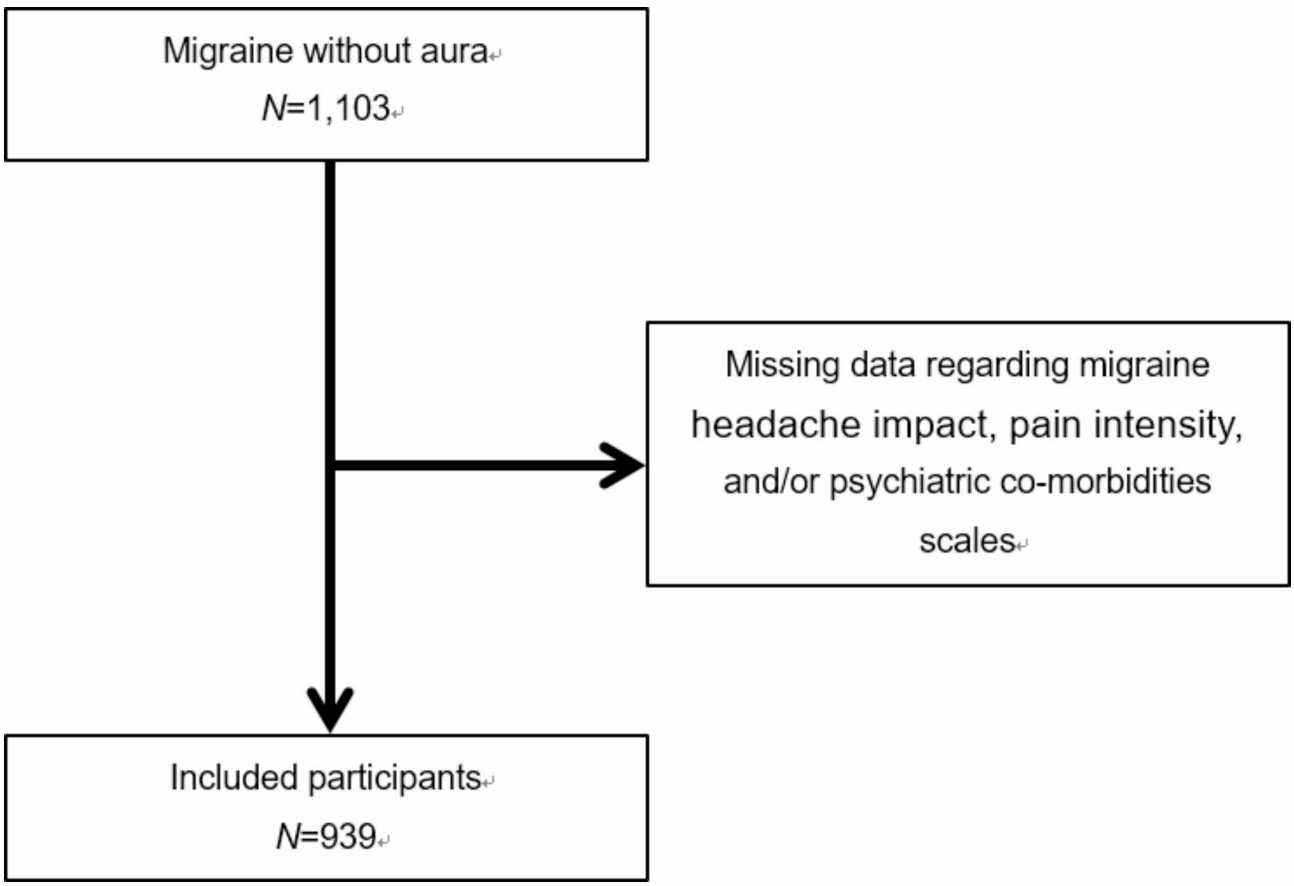

Fig. 1. Flow chart of the study.

Description	Participants
Gender, n (%) Women Men	 679 (72.3) 260 (27.7)
Age (years), median (IQR)	32.0 (22.0, 44.0)
Nausea, n (%)	560 (59.6)
Vomiting, n (%)	224 (23.9)
Photophobia, n (%)	254 (27.1)
Phonophobia, n (%)	306 (32.6)
Osmophobia, n (%)	156 (16.6)
Allodynia, n(%)	161 (17.1)
HIT-6, median (IQR)	61.0 (56.0, 65.0)
VAS, median (IQR)	70.0 (50.0, 80.0)
GAD-7, median (IQR)	4.0 (2.0, 8.0)
PHQ-9, median (IQR)	4.0 (2.0, 8.0)

Table 1. Characteristics of the study population ($n = 939$). IQR: interquartle range; HIT-6: Headache Impact Test; VAS: visual analogue scale; GAD-7: Generalized Anxiety Disorder 7-item; PHQ-9: patient Health Questionnaire-9.

	Present	Absent	*P* value*
HIT-6			
Nausea	61.82 (61.27–62.37)	57.85 (57.12–58.58)	< 0.001
Vomiting	62.91 (62.00–63.83)	59.37 (58.86–59.89)	< 0.001
Phonophobia	62.65 (61.91–63.38)	59.32 (58.76–59.87)	< 0.001
Photophobia	62.12 (61.40–62.85)	59.30 (58.73–59.87)	< 0.001
Osmophobia	62.92 (61.91–63.92)	59.68 (59.17–60.18)	< 0.001
Allodynia	63.04 (62.10–63.97)	59.63 (59.12–60.14)	< 0.001
VAS			
Nausea	67.68 (66.21–69.14)	60.07 (58.32–61.81)	< 0.001
Vomiting	71.47 (69.06–73.88)	62.45 (61.19–63.72)	< 0.001
Phonophobia	71.23 (69.12–73.33)	62.15 (60.83–63.47)	< 0.001
Photophobia	70.46 (68.45–72.48)	61.77 (60.44–63.11)	< 0.001
Osmophobia	70.25 (67.36–73.14)	63.48 (62.25–64.71)	< 0.001
Allodynia	73.14 (70.80–75.47)	62.84 (61.58–64.10)	< 0.001
GAD-7			
Nausea	5.79 (5.40–6.18)	4.52 (4.10–4.94)	< 0.001
Vomiting	5.39 (4.81–5.98)	5.24 (4.91–5.57)	0.499
Phonophobia	6.50 (5.92–7.08)	4.82 (4.49–5.15)	< 0.001
Photophobia	6.07 (5.57–6.57)	4.89 (4.54–5.24)	< 0.001
Osmophobia	7.09 (6.26–7.92)	4.91 (4.61–5.21)	< 0.001
Allodynia	7.14 (6.42–7.87)	4.89 (4.58–5.20)	< 0.001
PHQ-9			
Nausea	6.07 (5.66–6.48)	4.52 (4.10–4.94)	< 0.001
Vomiting	5.88 (5.26–6.50)	5.31 (4.96–5.65)	0.049
Phonophobia	6.69 (6.04–7.35)	4.98 (4.54–5.24)	< 0.001
Photophobia	6.36 (5.80–6.92)	5.00 (4.65–5.35)	< 0.001
Osmophobia	6.81 (5.92–7.71)	5.17 (4.86–5.48)	0.001
Allodynia	7.55 (6.72–8.38)	5.01 (4.69–5.32)	< 0.001

Table 2. Relationship between of associated features and headache impact, pain intensity, or psychiatric co-scores: odds ratio and 95% confidence interval. * Mann-Whitney U test. HIT-6: Headache Impact Test; VAS: visual analogue scale; GAD-7: Generalized Anxiety Disorder 7-item; PHQ-9: patient Health Questionnaire-9.

	OR	95% CI	*P* value
HIT-6			
Nausea	1.87	1.37–2.54	**< 0.001**
Vomiting	1.57	1.11–2.23	**0.011**
Phonophobia	1.67	1.18–2.35	**0.004**
Photophobia	1.32	0.96–1.82	0.083
Osmophobia	0.81	0.54–1.22	0.320
Allodynia	1.56	1.06–2.28	**0.023**
VAS			
Nausea	1.72	1.22–2.43	**0.002**
Vomiting	1.84	1.29–2.63	**< 0.001**
Phonophobia	1.58	1.10–2.25	**0.013**
Photophobia	1.49	1.07–2.08	**0.019**
Osmophobia	0.86	0.56–1.30	0.460
Allodynia	1.81	1.24–2.66	**0.002**
GAD-7			
Nausea	1.49	1.09–2.02	**0.012**
Vomiting	0.81	0.57–1.16	0.249
Phonophobia	2.00	1.42–2.82	**< 0.001**
Photophobia	1.17	0.85–1.61	0.328
Osmophobia	1.09	0.73–1.63	0.681
Allodynia	1.81	1.24–2.63	**0.002**
PHQ-9			
Nausea	1.66	1.21–2.28	**0.002**
Vomiting	0.54	0.37–0.78	**0.001**
Phonophobia	1.49	1.05–2.11	**0.025**
Photophobia	1.29	0.93–1.78	0.128
Osmophobia	1.16	0.77–1.74	0.482
Allodynia	1.68	1.16–2.45	**0.007**

Table 3. Odds ratio (OR) and 95% confidence interval (CI) from multiple logistic regression models of associated features on headache impact, pain intensity, or psychiatric scores. HIT-6: Headache Impact Test; VAS: visual analogue scale; GAD-7: Generalized Anxiety Disorder 7-item; PHQ-9: patient Health Questionnaire-9. Significant values are in bold.

Nagelkerke R^2 values were 0.111, 0.132, 0.086, and 0.068, respectively. The results of HIT-6 analysis indicated a significant association between higher scores and various symptoms. Specifically, individuals with higher HIT-6 scores were 1.87 times more likely to experience nausea ($p < 0.001$), 1.57 times more likely to experience vomiting ($p = 0.011$), 1.67 times more likely to experience phonophobia ($p = 0.004$), and 1.56 times more likely to experience allodynia ($p = 0.023$). However, photophobia and osmophobia were not significantly associated with higher HIT-6 scores ($p = 0.083$ and $p = 0.320$, respectively).

Similarly, VAS results revealed significant associations with certain symptoms. Higher VAS scores were associated with a 1.72 times higher odds of nausea ($p = 0.002$), 1.84 times higher odds of vomiting ($p < 0.001$), 1.58 times higher odds of phonophobia ($p = 0.013$), 1.49 times higher odds of photophobia ($p = 0.019$), and 1.81 times higher odds of allodynia ($p = 0.002$). Osmophobia was not significantly associated with higher VAS scores ($p = 0.460$).

In relation to GAD-7 scores, individuals with higher scores showed associations with symptoms such as nausea (1.49 times more likely, $p = 0.012$), phonophobia (2.00 times more likely, $p < 0.001$), and allodynia (1.81 times more likely, $p = 0.002$). However, vomiting, photophobia, and osmophobia were not significantly associated with higher GAD-7 scores ($p = 0.249$, $p = 0.328$, and $p = 0.681$, respectively).

Analysis of the PHQ-9 scores revealed several significant associations. Higher PHQ-9 scores were associated with 1.66 times higher odds of nausea ($p = 0.002$), lower odds of vomiting (odds ratio = 0.54, $p = 0.001$), higher odds of phonophobia (1.49 times higher odds, $p = 0.025$), and higher odds of allodynia (1.68 times higher odds, $p = 0.007$). However, photophobia and osmophobia were not significantly associated with higher PHQ-9 scores ($p = 0.128$ and $p = 0.482$, respectively).

Discussion

This study investigated the effects of migraine-associated symptoms on headache severity, pain intensity, and psychiatric comorbidities in patients with MwoA. Multiple logistic regression analysis revealed that symptoms such as nausea, phonophobia, photophobia, and allodynia were significantly associated with increased headache impact, pain intensity, and psychiatric scores, as measured using the HIT-6, VAS, GAD-7, and PHQ-9 scores.

These findings are consistent with previous studies that highlight the role of these symptoms in exacerbating migraine-related disability and pain[2,3,26]. Vomiting was also identified an independent positive predictor of headache impact, pain intensity, and scores, including HIT-6 and VAS scores, and an independent negative predictor of PHQ-9 scores. This may be because patients experiencing vomiting may seek and receive immediate medical attention, leading to better management of their migraine episodes and, indirectly, their psychiatric symptoms. Photophobia was a positive predictor of VAS scores but not HIT-6, GAD-7, or PHQ-9 scores. Similar to vomiting, these results could potentially explain why patients experiencing photophobia seek and receive medical attention, leading to better management of their migraine episodes and, indirectly, their psychiatric symptoms. Another possibility is that photophobia is not an independent factor, because of its strong association with other symptoms. Osmophobia was not an independent factor for most outcomes, possibly because of its strong association with other symptoms.

Our findings align with and diverge from existing literature in several ways. Notably, the comprehensive association of HIT-6, VAS, and ASC scores with all associated features was consistent with the findings of previous studies, whereas the nuanced relationship between specific symptoms and psychological well-being provides a novel perspective. Our study identified significant associations between certain migraine-associated symptoms and psychiatric conditions, as assessed using GAD-7 and PHQ-9 scores. These findings are in line with those of Yin et al.[27], who reported a high prevalence of psychiatric comorbidities, such as depression and anxiety, among patients with migraines.

A study of 1025 individuals with migraines that investigated the non-parametric correlation between headache intensity, duration, and associated symptoms revealed that headache intensity was significantly correlated with nausea, vomiting, photophobia, phonophobia, and osmophobia[2]. Our study also showed that headache intensity, as assessed using the VAS, had a significant non-parametric correlation with nausea, vomiting, photophobia, phonophobia, and osmophobia.

In terms of the existing literature, one priro nationwide study based on face-to-face questionnaires administered by physicians revealed that 61.1% of patients with migraines experienced allodynia[3]. Another previous study found that cutaneous allodynia in patients with migraines was significantly associated with comorbid chronic pain conditions, anxiety, depression, female sex, smoking, and other demographic- and migraine-specific factors, with a higher number of pain conditions increasing the likelihood of severe allodynia[28]. Patients with migraine with aura or a family history of migraine reported allodynia more commonly than those without migraines. Another study investigated the prevalence of allodynia during migraine attacks in 221 outpatients and found that allodynia was more frequently reported in patients with migraine with aura (65%) and chronic migraine (65.9%), compared to 41.2% in patients with MwoA[16]. In our study, allodynia was significantly associated with the severity of migraine attacks. The low prevalence of allodynia (16.1%) in our study may be attributed to the inclusion of MwoA and/or the use of different methods to investigate allodynia.

One study using part of the Turkish Headache Database retrospectively analyzed 835 patients with chronic migraine, finding that increased duration and intensity of attacks were associated with more accompanying symptoms, such as phonophobia, nausea, and photophobia, whereas a higher frequency of headaches was inversely related to these symptoms[4]. Osmophobia is a common symptom in patients with chronic migraines, and is closely associated with other symptoms. Our study also showed a relationship between attack intensity and the associated features. The close association between osmophobia and other symptoms supports our hypothesis that osmophobia is not an independent risk factor for most outcomes.

A previous study analyzing 782 patients, including 213 with migraine, found that symptoms of anxiety assessed using GAD-7 scores, particularly the inability to control worrying and difficulty relaxing, were more significantly associated with migraine than depression assessed using PHQ-9 scores, which presented with more physical symptoms such as appetite changes, fatigue, and poor sleep[5]. Our study also revealed that the median GAD-7 score was the same as the mean PHQ-9 score. These different results may be due to different study populations, as our study included only patients with MwoA.

This study revealed that the frequencies of nausea, vomiting, photophobia, and phonophobia among the study participants were 59.6%, 23.9%, 32.6%, and 27.1%, respectively. These frequencies are notably lower than those reported in traditional migraine populations[4,29–31]. For example, Yalın et al. reported much higher frequencies in patients with chronic migraine, with nausea present in 77.6%, vomiting in 40.9%, photophobia in 71.2%, and phonophobia in 80.2% of patients[32]. Similarly, Kim et al. reported higher frequencies in a population-based study from Korea, identifying photophobia in 73.5% and phonophobia in 80.6% of patients with migraines[13]. Tu et al. also reported higher frequencies in a hospital-based study in Taiwan, with photophobia in 70.9% and phonophobia in 86.3% of patients with migraines[33]. The discrepancies between our findings and those of traditional studies on migraines could be attributed to several factors. First, our study cohort may have differed demographically or clinically from those of previous studies, potentially affecting the prevalence of associated symptoms. Additionally, the methods of data collection and symptom reporting may vary, possibly influencing the observed frequencies.

Prior studies have broadly investigated the phenotypes, associated symptoms, and relationships between comorbid conditions and lifestyle in patients[4,26–31]. This study is distinctive in that it provides a comprehensive and detailed examination of the impact of individual symptoms, with a specific focus on patients with MwoA. This study also provides a detailed analysis of the impact of individual symptoms, particularly nausea, vomiting, photophobia, phonophobia, allodynia, and osmophobia, on headache intensity and psychiatric conditions. However, this topic has not been thoroughly investigated. In particular, our study, evaluating the effects of allodynia and osmophobia and their association with mental health, introduces new perspectives in migraine studies. These insights may contribute to the development of personalized migraine management strategies.

Limitations

The primary limitations of this study include population specificity, reliance on self-reported scales, lack of control for confounding variables, and its cross-sectional design. Regarding population specificity, this study focused exclusively on patients with MwoA, thereby limiting the generalizability of the findings to other types of migraine and headache disorders.

This study also used self-report scales to assess the impact of migraine headaches, pain intensity, and psychiatric conditions. However, this method introduces the potential for recall bias, social desirability bias, or measurement error, which can influence the accuracy of the reported data. Further, this study did not account for various potential confounding factors including medication use, comorbidities, lifestyle, or genetic factors. This omission may have affected the interpretation of the associations between migraine-related characteristics and headache impact, pain intensity, or psychiatric conditions.

One notable limitation of our study was the absence of Migraine Disability Assessment (MIDAS) data. Although we initially considered headache frequency as a variable to provide a more comprehensive assessment of the headache impact, we ultimately used the Pediatric Migraine Disability Assessment (PedMIDAS) for pediatric and adolescent patients. The decision to focus on the PedMIDAS was driven by its suitability for younger demographics in our study cohort. In accordance with the reviewer's suggestions, we have reviewed both PedMIDAS and MIDAS data to enhance the robustness of our findings. Due to the anonymization process implemented in our study, we were unable to access detailed MIDAS information.

On multivariable logistic regression analysis, Hosmer-Lemeshow test yielded p-values of 0.121, 0.748, 0.737, and 0.464 for the HIT-6, VAS, GAD-7, and PHQ-9, respectively. As all p-values surpassed the conventional threshold of 0.05, it can be concluded that no significant discrepancy existed between the observed and predicted outcomes in these models. However, when the explanatory power of these models was evaluated using Nagelkerke's R^2, the values were found to be relatively low (HIT-6 = 0.111; VAS = 0.132; GAD-7 = 0.086; and PHQ-9 = 0.068), indicating that the models accounted for only a minor proportion of the variability in the outcome, with each model explaining less than 14% of the variance. Further research should consider the inclusion of additional variables or alternative modelling techniques to capture the intricacies of the factors influencing the outcome more comprehensively.

The final limitation of this study is its cross-sectional design, which hindered the establishment of causal or temporal relationships between migraine-associated features and disabilities or psychiatric conditions. This limitation restricts the ability to draw definitive conclusions regarding cause-and-effect relationships within the observed variables.

Clinical implications

Overall, the findings of this study underscore the heterogeneous impact of different features associated with migraine headaches, pain intensity, and psychiatric conditions. This knowledge could inform personalized and targeted management strategies for patients with MwoAs. Clinicians could further use these results to guide discussions with patients and help them understand the potential impact of specific migraine-associated features on their overall well-being. This facilitates shared decision-making in the treatment plans. Identification of independent predictors of psychiatric conditions, such as nausea and osmophobia for GAD-7, also allows for the early recognition of patients at higher risk. Early intervention and support may help to mitigate this impact on mental health. This study contributes to the current understanding of migraine by highlighting the differential effects of migraine-associated features. This knowledge will facilitate further research and lead to the development of targeted treatment protocols.

Conclusion

Overall, this study provides insight into the distinct effects of migraine-associated features on the disability and psychiatric condition of patients with MwoA. These findings contribute to the growing body of knowledge in migraine research and underscore the need for personalized treatment approaches in clinical practice.

Data availability

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

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Author contributions

NI and YM contributed to the study conception and design. NI and YM acquired the data. NI analyzed the data and was a major contributor to writing the manuscript. All the authors have read and approved the final version of the manuscript.

Declarations

Competing interests

The authors declare the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article. NI reports being an advisor for Sawai and receiving speaker fees from Daiichi Sankyo, Eli Lilly, Otsuka, and Amgen; however, these companies were not related to the study. YM reports personal consultancy fees from Amgen Astellas BioPharma K.K., Daiichi Sankyo Company Limited, Eli Lilly Japan K.K., and Otsuka Pharmaceutical Co., Ltd. during the conduct of the study; however, no company had any relation to the study.

Ethics approval and consent to participate

This study was conducted at two accredited headache education facilities endorsed by the Japanese Headache Society: the Japanese Red Cross Shizuoka Hospital and the Sendai Headache and Neurology Clinic. This was a two-center prospective investigation of patients with headache disorders. The participants provided informed consent in accordance with the Ethical Guidelines for Medical and Health Research Involving Human Subjects issued by the Japanese Ministry of Health, Labor, and Welfare. This study was approved by the Ethics Committee of the Japanese Red Cross Shizuoka Hospital (reference number: 2018–21).

Additional information

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