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Do headaches impact pregnancy planning behaviors? A cross-sectional school-based study in Japan

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Abstract

Objective Headache disorders are a common neurological disease with socioeconomic burdens among individuals of reproductive age, yet little is known about its impact on fertility intentions. This study examined the association between headache characteristics and fertility intention among parents of school-aged children with headaches in Japan.

Methods We prospectively conducted a school-based online survey for students' parents in Tsubame City, Japan, in 2024. We asked about their age, sex, headache characteristics, the use of acute and prophylactic medications; monthly headache days (MHD); monthly acute medication intake days (AMD); Headache Impact Test-6 (HIT-6); Migraine Interictal Burden Scale-4 (MIBS-4); and the number of children. We also examined the impact of headaches on pregnancy plans by asking, "Are you avoiding or have you avoided pregnancy due to headaches?" and those who answered "yes" to this question were defined as the "avoid pregnancy group."

Results Of the 5,227 households, we received 1,127 (21.6%) responses, and 599 responses from parents with headaches were analyzed. The median (first quartile-third quartile) age was 43 (40–48) years, and 562 (93.8%) were female. They reported median MHD: 3 (1–4) days, AMD: 3 (1–6) days, HIT-6: 60 (58–68), and MIBS-4: 4 (2–8). Fifty (8.3%) used prophylactic medications, and 492 (82.1%) used acute medications for headache attacks. The median number of children was 2 (2–2). Twenty-two of the 562 female respondents (3.9%) answered that they were avoiding or had avoided pregnancy due to headaches. Both the HIT-6 score (median 58 [53–64] vs. 63 [59–66], $p=0.033$) and the MIBS-4 score (4 [2–7] vs. 6 [4–7], $p=0.012$) were significantly higher in the avoid pregnancy group. Multivariable analysis showed that avoid pregnancy group was significantly associated with: older age (odds ratio [OR] 1.16, 95% confidence interval [CI]: 1.05–1.29, $p=0.004$), shorter headache duration (OR 0.91: 95%CI 0.85–0.98, $p=0.016$), and a greater number of MHD (1.08, 95%CI: 1.01–1.16, $p=0.031$), the presence of nausea or vomiting (OR 6.11, 95%CI: 1.46–25.60, $p=0.013$), and phonophobia (OR 6.40, 95%CI: 1.71–23.99, $p=0.006$). The avoid pregnancy group was more likely to express concerns about disability during pregnancy, parenting, and potential harm from medications.

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Conclusions Some of the respondents were avoiding or had avoided pregnancy because of their headaches. Those in the avoid pregnancy group had both ictal and interictal severe headache burden and felt that headache disorders negatively affected fertility intention.

Keywords Family planning, Fertility intention, Infertility, Migraine, Pregnancy planning, Stigma

Introduction

Japan faces critical issues with its declining birthrate and aging population. The number of births in Japan has decreased from around 1 million in 2015 to 810,000 by 2021, falling at an annual rate of 3.5%. This decline is attributed to population changes, marriage rates, and decreased fertility intention among women. Specifically, the declining fertility intention, influenced by the deteriorating economic and employment environment for young Japanese, is a major driver [1]. The employment advancement of women in Japan has outpaced the development of support systems for working mothers, leading to issues like daycare shortages, low salaries, long working hours, and high child-raising costs, which contribute to women postponing pregnancy [2]. This situation leads to what is termed 'social infertility,' where women are unable to have children due to societal or economic barriers, such as the lack of support for working mothers, rather than biological limitations, thereby affecting both individual women and the broader population dynamics.

Headache disorders, such as migraine, tension-type headache (TTH), and trigeminal autonomic cephalalgias (TACs) as classified by the International Classification of Headache Disorders, 3rd edition (ICHD-3) [3], are prevalent neurological conditions causing a significant global socioeconomic burden [4]. In Japan, migraine prevalence is around 8.4% [5], with substantial disruptions to daily activities reported by 29.8–74.2% of sufferers [6]. TTH affects approximately 15–20% of the population, with 22.4–29.2% experiencing reduced productivity [7]. Also, medication-overuse headache (MOH), present in around 2.3% of the population [8], makes headaches chronic and severe, which makes them difficult to treat with medications [9]. TACs are diagnosed in about 3.5% of patients at headache clinics, which are characterized by prominent headache attacks with ipsilateral cranial autonomic features [10]. Effective management of headache disorders is crucial, including acute and prophylactic medication with an accurate diagnosis under ICHD-3 criteria [11].

Headache disorders, including both migraine and TTH, have substantial economic and social impacts [7, 12, 13], affecting patients' quality of life and causing anxiety about future attacks [14–16]. Given that headache disorders create social and economic strain, we hypothesized that migraine and headaches influence fertility intention. Previously, one migraine patient-based report from headache-specialized clinics in the United States [17], one web-based survey report from migraine patients in the United States [18], and a cross-sectional survey on migraine headache patients in Europe [19] revealed varying prevalence rates, ranging from 1 to 20%, of migraine patients reported that they avoided pregnancy because of migraine. However, there is a lack of data on the relationship between headache disorders and pregnancy planning in Japan. Therefore, we conducted a school-based online survey for parents to investigate the impact of headache disorders on fertility intention in Japan and to identify what headache disorders are associated with fertility intention.

Materials and methods

Online questionnaire procedure

This prospective survey was conducted between September and December 2024 in Tsubame City, Niigata Prefecture, Japan, through a collaborative effort between Nagaoka University of Technology and the Tsubame City Board of Education. Tsubame City has a total population of 75,931, with 43,705 individuals (57.6%) in the working-age (15–64 years) group and 24,312 (32.0%) in the retirement-age (65 years or older) group. The number of elementary and junior high school students aged 7–15 is 5,227 (6.9%), and all households were invited to participate in this online survey. Primary and secondary industries account for 3.7% and 41.1% of the city's population. Compared to Japan as a whole, secondary industries, such as the metal processing industry, make up a significant share of the city's workforce. There are no dedicated headache outpatient clinics or certified headache specialists in Tsubame City. Tsubame City was selected as the study site, considering its accessibility from our research institution and the logistics of study implementation.

After obtaining approval from the Board of Education, requests for participation were distributed to parents through each school, both in paper form and online platforms. Starting in 2021, each student was provided with a loaned tablet, enabling interactive remote learning during school closures following the coronavirus disease-19 pandemic. The students' parents were asked to answer the questionnaire through Google Forms using the tablet devices or their own smartphones. One parent was asked to respond, but no specific instruction was given regarding whether it should be the father or the mother. There were no missing data among the valid responses.

Questionnaire items

We collected information on the respondent's age, biological sex, and the presence of headache attacks within the past three months, excluding those related to infections such as the common cold or head injuries. For those who reported having headaches, we further assessed the number of children, headache characteristics, including duration of headache attacks, monthly headache days (MHD), and the presence of specific symptoms: unilateral pain, pulsating pain, moderate or severe pain, aggravation by routine physical activity, nausea or vomiting, photophobia, phonophobia, and osmophobia [20], according to the ICHD-3 [3]. Although we did not ask participants whether they had received a formal medical diagnosis, we classified them as having migraine or MOH based on their questionnaire responses, according to the ICHD-3 criteria. These headache types were inferred from ICHD-3-aligned responses, not clinically diagnosed. These items in this questionnaire were used in our previous study [8].

We also evaluated the burden of headache using the Headache Impact Test-6 (HIT-6) and the Migraine Interictal Burden Scale-4 (MIBS-4). HIT-6 is a validated tool designed to assess the overall burden of headache disorders on quality of life across six domains, including pain, functional limitations, vitality, and psychological distress [21]. MIBS-4 measures interictal migraine-related burden in 4 domains: impairment in work or school, impairment in family and social life, difficulty making plans or commitments, and emotional/affective and cognitive distress [22]. While the HIT-6 assesses specific symptoms and functional impairments caused by headache disorders, the MIBS-4 focuses on the psychological burden and future-oriented concerns experienced during headache-free periods.

In addition, we recorded the number of monthly acute medication intake days (AMD), whether acute medication had been used, and whether prophylactic medication had been taken in the past three months. Acute medications were indicated in the questionnaire as over-the-counter and prescribed non-steroidal anti-inflammatory drugs (NSAIDs), triptans, and lasmiditan. Prophylactic medications were indicated as lomerizine, propranolol, valproic acid, amitriptyline, and calcitonin gene-related peptide (CGRP)-related drugs, according to the Clinical Practice Guideline for Headache Disorders 2021 [11].

Participants who reported having headaches were asked whether their condition had affected their plans regarding pregnancy. The question "Have headaches impacted your plans for pregnancy? In other words, are you avoiding or have you avoided pregnancy due to headaches?" offered three response options: "Yes. I am avoiding, or I have avoided pregnancy due to headaches (avoid pregnancy)," "No. I am NOT avoiding, or I have NOT avoided pregnancy due to headaches (no impact)," and "I am or have been more likely to want to get pregnant due to headaches (increased desire to get pregnant)." We exploratorily examined the reasons why headaches would affect pregnancy using six individual questions on beliefs and reproductive concerns associated with headaches. Q1: My headaches would be worse during or just after pregnancy. Q2: Disability caused by headaches makes pregnancy very difficult. Q3: Disability caused by headaches makes raising a child very difficult. Q4: The headache medications I take would negatively affect my child's development. Q5: Headaches would cause my baby to have abnormalities at birth. Q6: I would pass on genes to my baby that increase the risk of my baby having headaches. These questions were the same as in the previous report on the relationship between migraine and fertility intention [17], with yes/no answers. Menstrual-related headache worsening was also assessed to determine its relationship with the belief that headaches interfere with pregnancy.

Statistical analysis

Descriptive statistics are presented as median (first quartile; Q1 – third quartile; Q3) for values without normal distribution or as number (percentage). Patients were divided into two groups: the "avoid pregnancy" group, which selected "avoid pregnancy," and the "no impact" group, which selected either "no impact" or "increased desire to get pregnant." We compared the characteristics between these two groups. This is the primary analysis of these datasets, and the nature of this analysis was preplanned. Chi-squared and Fisher's exact tests were performed to compare proportions, and the Mann-Whitney U test was performed to compare numerical values as univariable analysis. Multivariable analysis using logistic regression was then employed to identify the headache characteristics associated with the avoid pregnancy group. Headache characteristics were used as variables, but characteristics not directly associated with the nature of the headaches, such as treatments (e.g., AMD, presence of acute and prophylactic medication) and psychological evaluations on headache burden (including HIT-6 and MIBS-4), were excluded. The variables regarding treatments and psychological evaluations are tested by univariable analysis. All explanatory variables were entered simultaneously using the forced-entry method.

For the chi-square and Fisher's exact tests, Cramér's V was used to measure effect size. The effect size for the Mann–Whitney U test was calculated using r, derived from the standardized test statistic (Z) divided by the square root of the total sample size. According to Cohen's guidelines, values of approximately 0.1, 0.3, and 0.5 indicate small, medium, and large effects, respectively. In the multivariable analysis, odds ratios with corresponding

95% confidence intervals were used as measures of effect size, indicating the strength and direction of association between independent variables and the outcome.

A priori statistical power calculation was not conducted. The target enrollment was based on the desire to sample as many residential individuals in the population as possible. A two-tailed $p < 0.05$ was defined as statistically significant. We used SPSS software version 29.0.0 (IBM Corp., Armonk, New York, USA), Python 3.9.0, Matplotlib 3.5.1, and seaborn 0.13.2.

Ethical aspects

The Ethics Committee of Nagaoka University of Technology approved this study (approval number: 2025-03-07). The questionnaire was anonymous and did not include any personally identifiable information. Participants were provided with an explanation of the study's purpose both in writing and through the online survey form. They were invited to complete the survey if they agreed to participate. If they were unable or chose not to participate, they were asked to submit a blank form, thereby allowing for the possibility of non-participation. We never forced the respondents to participate in this survey; we only invited them to participate of their own free will. All methods were carried out under the Declaration of Helsinki and STROBE guidelines for observational research. This study did not obtain any personal patient information to protect patient privacy. The requirement for written informed consent was waived. On the initial screen of the Google Form, participants were informed that their anonymous responses would be used for research purposes, and they were asked to consent before proceeding to the survey.

Results

Of the 5,227 households contacted, we received 1,127 responses (response rate: 21.6%). Among them, 10 explicitly declined participation, and 438 were from individuals without headaches. Although 679 respondents reported having headaches, 80 discontinued the questionnaire partway and were excluded from the analysis. Finally, 599 responses (11.5% of all invited) from parents with headaches were included in the analysis. The median (Q1-Q3) age was 43 (40–48) years, and 562 (93.8%) were female. They reported median MHD: 3 (1–4) days, AMD: 3 (1–6) days, HIT-6: 60 (58–68), and MIBS-4: 4 (2–8). Based on the response in the survey and classification according to ICHD-3, migraine comprised 137 (22.9%), MOH 24 (4.0%), and both of them 8 (1.3%). Of the 599 respondents, 492 (82.1%) used acute medications for headache attacks, and 50 (8.3%) used prophylactic medications (Supplementary Table 1).

Among the 599 participants with headaches, 562 (93.8%) were categorized in the "no impact" group, which included three respondents who reported an "increased desire to get pregnant" due to headaches. The remaining 22 participants (3.7%) were classified in the "avoid pregnancy" group. As a sensitivity analysis, we estimated the potential range of prevalence for pregnancy avoidance by including all non-responders ($n = 4{,}628$) in two extreme-case scenarios. In the best-case scenario, assuming that none of the non-responders avoided pregnancy due to headaches, the adjusted prevalence was 0.42%. In the worst-case scenario, assuming that non-responders had the same proportion of pregnancy avoidance as responders (3.7%), the adjusted prevalence was 3.67%.

Since all participants in the "avoid pregnancy" group were female (562 respondents, 93.8%), statistical comparisons regarding pregnancy intentions were conducted among female respondents only in order to eliminate sex-related heterogeneity in pregnancy intentions. In the univariate analysis, the avoid pregnancy group (median age 47 [Q1-Q3: 44–49]) was significantly older than the no impact group (43 [39–46], $p < 0.001$), and their headache duration was shorter (8 [3–8] hours) than the no impact group (8 [4–24], $p = 0.019$). There was no significant difference in MHD between the avoid pregnancy group (4 [3–6]) and no impact group (3 [2–5], $p = 0.106$). The avoid pregnancy group had a higher-than-expected proportion of respondents with both migraine and MOH, as determined by Fisher's exact test (33.3% of them, $p < 0.001$). Regarding headache burden, the avoid pregnancy group had significantly higher HIT-6 (63 [59–66]) and MIBS-4 scores (6 [4–7]) than the no impact group (58 [53–64], $p = 0.033$ and 4 [2–7], $p = 0.012$, respectively). All participants in the avoid pregnancy group (100%) reported using an acute medication, which was a significantly higher proportion compared to the no impact group (80.7%, $p = 0.023$). However, AMD did not differ significantly between the avoid pregnancy group (2 [2-2]) and the no impact group (2 [1–5], $p = 0.190$). There were no patients using lasmiditan or CGRP-related drugs. Gepants had not yet been approved in Japan in 2024 (Table 1).

The analysis results, which were limited to female participants with migraines, are presented in Supplementary Table 2. Compared with the analysis of the entire female population, a common finding was that the headache duration was shorter in the avoid pregnancy group in female participants with migraines than those in the no impact group. A notable difference in the migraine-only analysis was that the avoid pregnancy group tended to have a higher MHD and AMD. There were no significant differences between the two groups regarding the use of acute or prophylactic medications.

In the multivariable logistic regression analysis in Table 2, avoid pregnancy group was significantly associated with: older age (odds ratio [OR] = 1.16, 95%

Table 1 Clinical characteristics and comparison between the no impact group and avoid pregnancy group in female sex

	Total ($n=562$)	IQR (Q1-Q3) or %	No impact group ($n=540$, 96.1%)	IQR (Q1-Q3) or %	Avoid pregnancy group ($n=22$, 3.9%)	IQR (Q1-Q3) or %	*p* values	*r* or Cramer's V
Age (years)	43	39–46	43	39–46	47	44–49	< 0.001*	0.145
Headache characteristics								
Duration of headache (h)	8	4–24	8	4–24	8	3–8	0.019*	−0.099
MHD (days/month)	3	2–5	3	2–5	4	3–6	0.106	0.068
Unilateral pain	289	51.4%	279	51.7%	10	45.5%	0.568	0.024
Pulsating pain	274	48.8%	265	49.1%	9	40.9%	0.435	0.032
Moderate or severe pain	120	21.4%	118	21.9%	2	9.1%	0.152	0.060
Aggravation by routine physical activity	105	18.7%	101	18.7%	4	18.2%	0.951	0.003
Nausea or vomiting	361	64.2%	346	64.1%	15	68.2%	0.694	0.017
Photophobia	127	22.6%	122	22.6%	5	22.7%	0.988	0.001
Phonophobia	264	47.0%	252	46.7%	12	54.5%	0.468	0.031
Osmophobia	94	16.7%	92	17.0%	2	9.1%	0.328	0.041
Diagnosis								
Migraine (-) and MOH (-)	406	72.2%	388	95.6%	18	4.4%	< 0.001*	0.173
Migraine (+) and MOH (-)	129	23.0%	127	98.4%	2	1.6%		
Migraine (-) and MOH (+)	21	3.7%	21	100%	0	0.0%		
Migraine (+) and MOH (+)	6	1.1%	4▽	66.7%	2▲	33.3%		
Burden								
HIT-6 (sum)	59	53–64	58	53–64	63	59–66	0.033*	0.090
MIBS-4 (sum)	4	2–7	4	2–7	6	4–7	0.012*	0.106
Treatment								
AMD (days/month)	2	1–5	2	1–5	2	2–2	0.190	0.055
Use of acute medication	458	81.5%	436	80.7%	22	100%	0.023*	0.096
Use of prophylactic medication	48	8.5%	46	8.5%	2	9.0%	0.925	0.004

The values are actual numbers or median. The complete description of both sexes is provided in Supplementary Table 1

Abbreviations: *AMD* Acute medication intake days, *HIT-6* Headache Impact Test-6, *IQR* Interquartile range, *MHD* Monthly headache days, *MIBS-4* Migraine Interictal Burden Scale-4, *MOH* Medication-overuse headache, *NSAIDs* Non-steroidal anti-inflammatory drugs, *OTC* Over-the-counter, *Q1* first quartile, *Q3* third quartile, *r* effect size for Mann-Whitney U test, ▲ More than expected frequency by the chi-square test, ▽ Less than expected frequency by the chi-square test

confidence interval [CI]: 1.05–1.29, $p=0.004$), shorter headache duration (OR = 0.91, 95% CI: 0.85–0.98, $p=0.016$), a greater number of MHD (OR = 1.08, 95% CI: 1.01–1.16, $p=0.031$), the presence of nausea or vomiting (OR = 6.11, 95% CI: 1.46–25.60, $p=0.013$), and phonophobia (OR = 6.40, 95% CI: 1.71–23.99, $p=0.006$). Other headache features such as unilateral pain, pulsating pain, moderate or severe pain, photophobia, and osmophobia were not significantly associated. The logistic regression model demonstrated acceptable explanatory power, with a Nagelkerke's R^2 of 0.373. The overall model was statistically significant (χ^2 = 40.5, $p<0.001$). The forest plot is shown in Fig. 1.

The median number of children was significantly lower in the avoid pregnancy group (1.5 [1-2]) compared to the no impact group (2 [2-2], $p<0.001$). The proportion of participants who reported worsening headaches during menstruation did not significantly differ between the avoid pregnancy group (17 [77.3%]) and the no impact group (330 [61.1%], $p=0.284$). Regarding beliefs and reproductive concerns associated with headache, participants in the avoid pregnancy group were significantly more likely to agree with several negative perceptions about the impact of headaches on pregnancy and child-raising: In the avoid pregnancy group, 63.6% of participants agreed with the statement "Q2: Disability caused by headaches makes pregnancy very difficult," while 16.3% of participants in the no impact group agreed ($p<0.001$). Similarly, 45.5% of participants in the avoid pregnancy group and 18.4% of participants in the no impact group agreed with the statement "Q3: Disability caused by headaches makes raising a child very difficult" ($p<0.001$). For the statement "Q4: The headache medications I take would negatively affect my child's development," 77.3% of participants in the avoid pregnancy group and 48.9% of participants in the no impact group agreed ($p<0.001$) (Table 3).

Discussion

Through this school-based online survey conducted among parents with headaches, 22 out of 599 respondents (3.7%) reported that they had avoided pregnancy

Table 2 Multivariable logistic regression analysis of headache characteristics associated with avoid pregnancy group

	Odds ratio	95% confidence interval	*p* values
Age (years)	1.16	1.05–1.29	0.004*
Duration of headache (h)	0.91	0.85–0.98	0.016*
MHD (days/month)	1.08	1.01–1.16	0.031*
Unilateral pain	0.67	0.26–1.78	0.428
Pulsating pain	0.37	0.12–1.14	0.084
Moderate or severe pain	0.27	0.04–2.02	0.201
Aggravation by routine physical activity	4.01	0.89–18.01	0.070
Nausea or vomiting	6.11	1.46–25.60	0.013*
Photophobia	1.72	0.42–7.01	0.448
Phonophobia	6.40	1.71–23.99	0.006*
Osmophobia	0.22	0.03–1.58	0.131

This table presents the results of a multivariable logistic regression analysis examining which headache characteristics were associated with the avoid pregnancy group (as 1) or no impact group (as 0). All explanatory variables were entered simultaneously using the forced-entry method. Odds ratios greater than 1 indicate a higher likelihood of avoiding pregnancy. *P*-values less than 0.05 were considered statistically significant and are marked with an asterisk (*). The logistic regression model demonstrated acceptable explanatory power, with a Nagelkerke's R^2 of 0.373. The overall model was statistically significant ($\chi^2 = 40.5$, $p < 0.001$). MHD; monthly headache days

due to headaches. Compared to the no impact group, the avoid pregnancy group was older, had shorter headache duration, a greater MHD, and were more likely to report symptoms such as nausea or vomiting and phonophobia. They also had significantly higher scores on both the HIT-6 and MIBS-4. In addition to having fewer children, participants in the avoid pregnancy group were significantly more likely to agree with statements reflecting disability-related concerns about pregnancy and parenting, as well as concerns regarding the negative impact of headache medications on child development. To our knowledge, this is the first study to explore the relationship between headache disorders and pregnancy planning among parents of school-aged children in Japan.

Previous reports on migraine and pregnancy planning

Previous studies on migraine patients have reported varying rates of pregnancy avoidance. Ishii et al. [17] noted that 19.9% of patients in the American Registry for Migraine Research avoided pregnancy, while Buse et al. [18] reported that 3.2% of individuals with migraine in the CaMEO Study reported that they did not have children, delayed having children, or had fewer children because of migraine. Lampl et al. [19] found a lower rate of around 1% in the Eurolight dataset from Europe. These differences may be explained by variations in target populations, study methodologies, and cultural contexts. While these studies focused specifically on migraine, our survey included a broader range of headache types and found a lower avoidance rate of 3.7%. Although diagnoses in our study (Table 1) were based on self-reported questionnaire data rather than clinical confirmation, some individuals who avoided pregnancy did not meet the criteria for migraine. This suggests that not only migraine but also other headache disorders may influence reproductive decision-making.

Regarding underlying concerns among patients with migraine for pregnancy, previous studies have emphasized fears about migraine worsening [17], pregnancy

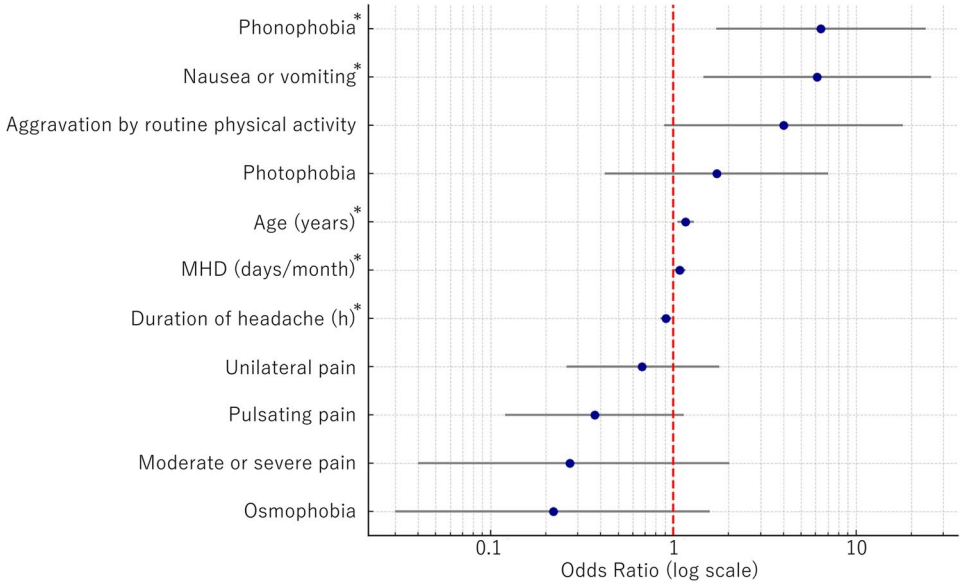

Fig. 1 Odds ratios and 95% confidence intervals from the multivariable logistic regression analysis identifying headache characteristics associated with the avoid pregnancy group. Odds ratios greater than 1 indicate an increased likelihood of being in the avoid pregnancy group. Horizontal lines represent 95% confidence intervals. A red dashed vertical line indicates OR = 1. Asterisks (*) denote statistically significant predictors ($p < 0.05$). MHD; monthly headache days

Table 3 Beliefs and reproductive concerns related to headache among the avoid pregnancy group versus the no impact group in the female sex

	Total (*n* = 562)	IQR (Q1-Q3) or %	No impact group (*n* = 540, 96.1%)	IQR (Q1-Q3) or %	Avoid pregnancy group (*n* = 22, 3.9%)	IQR (Q1-Q3) or %	*p* values	*r* or Cramer's V
Number of children	2	2–2	2	2–2	1.5	1–2	< 0.001*	−0.140
Headaches worsen during menstruation; yes	347	61.7%	330	61.1%	17	77.3%	0.284	0.067
Q1: My headaches would be worse during or just after pregnancy; yes	100	17.8%	96	17.8%	4	18.2%	0.892	0.006
Q2: Disability caused by headache makes pregnancy very difficult; yes	106	18.9%	92	17.0%	14	63.6%	< 0.001*	0.259
Q3: Disability caused by headache makes raising a child very difficult; yes	114	20.3%	104	19.3%	10	45.5%	< 0.001*	0.166
Q4: The headache medications I take would negatively affect my child's development; yes	284	50.5%	267	49.4%	17	77.3%	< 0.001*	0.140
Q5: Headache would cause my baby to have abnormalities at birth; yes	57	10.1%	57	10.6%	0	0%	0.133	0.067
Q6: I would pass on genes to my baby that increase the risk of my baby having headache; yes	319	56.8%	307	56.9%	12	54.5%	0.318	0.043

Abbreviations: *IQR* Interquartile range, *Q1* First quartile, *Q3* Third quartile, *r* Effect size for Mann-Whitney U test

difficulties [17, 18], and medication effects on child development [17]. Our findings showed a similar pattern: participants expressed concern over disability caused by headaches during pregnancy and child raising and the potential impact of medications. This suggests that headache disorders, regardless of type, may influence reproductive decisions through negative perceptions.

Headache characteristics in the avoid pregnancy group

Our multivariable analysis revealed that pregnancy avoidance was significantly associated with older age, shorter headache duration, higher MHD, and the presence of sensory hypersensitivity symptoms such as nausea or vomiting and phonophobia. In addition, participants in the avoid pregnancy group demonstrated significantly higher HIT-6 and MIBS-4 scores, suggesting a greater perceived burden of headache and stronger interictal anxiety.

Older maternal age may add pressure due to the perceived narrowing of the reproductive window. This sense of urgency, combined with the chronic headache burden, may intensify hesitation toward future pregnancy. Additionally, shorter duration but higher frequency headache attacks [23] may reflect headache conditions that intermittently disrupt daily life. These short-lasting headaches may occur during inconvenient times, such as while working or performing household tasks, leading to a scenario in which the headaches are not severe enough to warrant rest but still interfere with daily functioning. This "not enough to rest, but enough to disrupt" pattern can result in accumulating stress and psychological fatigue, especially when combined with cultural factors in Japan, where individuals are often expected to continue working or fulfilling household duties despite having headaches [6, 8].

Furthermore, sensory hypersensitivity symptoms—particularly nausea or vomiting and phonophobia—emerged as a strong relationship with pregnancy avoidance. Previous studies report that approximately 60% of migraine patients experience nausea during attacks [24], and nearly 30% continue to feel nauseous even in the postictal phase [25]. Phonophobia affects about 70% of migraine sufferers both during attacks [26] and during interictal periods, especially among women [27]. Furthermore, the co-occurrence of multiple sensory sensitivities has been associated with greater migraine-related burden and reduced quality of life, both in the ictal and interictal phase [28]. These sensory symptoms have also been linked to psychological consequences, such as depression [29], anticipatory anxiety, and avoidance behavior [30], suggesting that their impact extends beyond ictal episodes to interictal periods to affect patients' daily functioning and emotional well-being.

Considering the multivariable analysis results, combined with HIT-6 and MIBS-4 scores and the agreement with statements reflecting disability-related concerns about pregnancy and parenting, we propose the following hypothesis: in addition to the higher age and more MHD, individuals with sensory hypersensitivities experience a constant state of physical and psychological vulnerability—not only during migraine attacks but also in interictal periods—which may heighten their anxiety and depressive tendencies. Although migraine is often thought to improve during pregnancy [31], concerns about overlapping symptoms with morning sickness [32] or worsening of migraine in some cases [31] may increase anxiety. Additionally, for individuals with phonophobia,

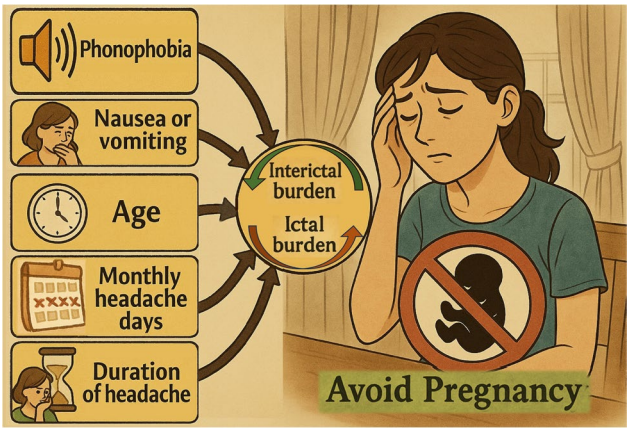

Fig. 2 Hypothetical model explaining the relationship between headache burden and pregnancy avoidance. This figure illustrates a proposed hypothesis based on our study findings: Pregnancy avoidance among individuals with headaches may be driven by multiple factors. Older maternal age may contribute to increased time-related anxiety about the narrowing reproductive window. Short-duration but frequent headaches disrupt daily activities and accumulate stress. Additionally, sensory hypersensitivities, particularly nausea and phonophobia, may enhance both interictal psychological vulnerability and ictal burden. These factors, combined with fears of worsening symptoms during pregnancy, overlapping with morning sickness, or concerns about the noise and unpredictability of child-raising, may lead individuals to avoid future pregnancy

the unpredictable noise environment of child-raising (e.g., baby crying) may serve as a major source of stress. Parents who have already experienced the challenges of pregnancy and childcare may thus develop a strong reluctance to undergo the same experience again. While this cross-sectional study cannot establish causal relationships, our findings suggest the need for detailed symptom-specific assessment and interventions that address both ictal and interictal burden, including care tailored to sensory hypersensitivity and anticipatory anxiety (Fig. 2).

Hypersensitivity and anxiety

From a neurobiological perspective, sensory hypersensitivities such as phonophobia and nausea may stem from altered central sensory processing and cortical hyperexcitability in individuals with migraine. Functional imaging studies have shown abnormal connectivity in pain and sensory networks, including the thalamus, insula, and brainstem nuclei, which contribute to a heightened perception of sensory stimuli even between attacks [33, 34]. Furthermore, increased connectivity between primary sensory cortices, the insula, and the amygdala in migraine patients suggests an enhanced emotional processing of sensory inputs [35]. This sensory hypersensitivity, coupled with the unpredictable nature of migraine attacks, fosters anticipatory anxiety and avoidance behavior [36]. In the context of pregnancy and parenting, where there are many unpredictable stresses, individuals with hypersensitivities may be more likely to avoid pregnancy. These mechanisms may partially explain why sensory hypersensitivities were significantly associated with pregnancy avoidance in our study.

Migraine, pregnancy, and postpartum period

Our results suggested that headaches can negatively influence fertility intention in some patients because there is more concern regarding the difficulty in pregnancy and parenting and the negative impact of headache medications on child development in the avoid pregnancy group. This highlights the need to improve awareness of the association between pregnancy and headache disorders, including migraine, and to promote evidence-based treatment for headache disorders during pregnancy and lactation. In this study, we investigated headache disorders in general; however, given that migraine is typically associated with greater disability and burden, we focused our literature discussion on migraine.

Migraine severity improves in 55–90% of pregnant women, and this may be because estrogen and endogenous opioids rise during pregnancy, raising the pain threshold [37]. However, some continue to experience attacks, and 7% report their first migraine attacks during pregnancy [38]. A prospective study conducted in a Japanese obstetrics department reported that 85% of women with migraine experienced remission during pregnancy, yet 63% experienced a recurrence within one month postpartum, with a significantly higher recurrence rate among women over 30 years old (78%) than those under 30 years old (35%) [39]. Considering the recent trends in Japan, such as increased maternal age and greater workforce participation among women, higher age, physical and social stressors related to childbirth and childcare may contribute to early postpartum migraine recurrence. The same study also demonstrated that breastfeeding was associated with lower migraine recurrence (71%) until six months postpartum, whereas bottle feeding was linked to higher rates of relapse (96%). In light of growing challenges in maintaining breastfeeding, particularly due to workplace constraints and limited support for working mothers in Japan, this protective effect by breastfeeding may be diminishing in recent years. These findings suggest that while migraine generally improve during pregnancy, more women may be experiencing postpartum difficulties due to social changes such as delayed childbearing and reduced breastfeeding opportunities. Our own findings suggest, at the very least, that many patients are unaware that migraines tend to improve during pregnancy, highlighting the need for greater public education and awareness of this evidence, especially for women who are planning to become pregnant.

For acute treatment of migraine, acetaminophen is recommended as the first line. Additionally, NSAIDs are not recommended in the third trimester due to the

heightened risk of premature closure of the ductus arteriosus [37]. Triptans, particularly sumatriptan, are now considered safe during pregnancy [40] while safety data for gepants and ditans remain lacking. For prevention, propranolol [41] and amitriptyline [42] are the recommended options. CGRP monoclonal antibodies (CGRP-mAbs) are effective migraine prophylactic medications, potentially improving fertility intentions if proven safe in pregnancy. However, their long half-lives (27–31 days) and lack of pregnancy safety data limit their use. Consequently, their use during pregnancy is not approved by the US Food and Drug Administration or European Medicines Agency. Recent reports describe six cases who had CGRP-mAbs during the periconceptional period. One of them experienced miscarriage, and another had severe perinatal asphyxia. However, the direct relationship between these events and CGRP-mAbs is unknown [43]. Animal studies with erenumab showed no adverse outcomes [44]. As large IgG molecules, CGRP-mAbs are unlikely to cross the placenta until after the first trimester via the neonatal Fc receptor [45], suggesting that stopping treatment upon pregnancy confirmation may minimize fetal exposure. Nonetheless, further studies are needed to establish the safety and appropriate management of CGRP-mAbs for women considering pregnancy.

During breastfeeding, migraine management should prioritize non-pharmacological interventions as first-line treatment, including behavioral strategies and lifestyle modifications. When medications are required for acute attacks, both acetaminophen and sumatriptan are generally considered safe during lactation. Ibuprofen and other NSAIDs may also be used cautiously [46]. For prophylactic treatment during breastfeeding, amitriptyline and propranolol are the commonly recommended options, as they have relatively favorable safety profiles and minimal transfer into breast milk. In contrast, valproic acid, topiramate, and hormonal agents such as estrogen-containing contraceptives are generally contraindicated due to potential risks to the infant [42, 46]. The safety of newer medications, including CGRP-mAbs, remains unclear [47].

Limitations

This study has several limitations. First, the survey was conducted among parents of school-aged children in Japan, and thus its generalizability is limited. The study population primarily consisted of mothers (93.8%) and excluded important populations such as individuals without children, younger adults/parents, and fathers. As a result, individuals who may have decided not to have children (potentially influenced by factors like headache burden) or whose children were not yet school age, were not captured. This focus on established mothers of school-aged children will result in an underestimation of the true impact of headache disorders on fertility intentions as it does not capture those mothers who decided to have no children due to their headache disorder. Furthermore, the predominance of mothers prevented any analysis of potential differences in attitudes between mothers and fathers. Additionally, cultural factors specific to Japan (e.g., workplace pressures, societal views on parenting and health) may influence the findings, further limiting generalizability to other cultural contexts. Future studies should aim to include more diverse populations (e.g., childless individuals, men, younger adults) and ideally incorporate cross-cultural comparisons to broaden the applicability of the findings.

Second, our study relied on self-reported data obtained via an online survey. Although headache type was estimated using structured symptom-based questions aligned with the ICHD-3, no formal diagnosis of migraine or MOH was made by a healthcare professional, and thus, clinical validation of headache diagnoses is needed in future research. Therefore, the term "headache" in this study broadly includes migraine, TTH, and possibly other types, which may vary in their impact on reproductive intentions. Furthermore, self-reported data are susceptible to recall bias, particularly for retrospective questions such as those regarding pregnancy avoidance. Our cross-sectional design also precludes any inferences of causality. To address these limitations, we emphasize the need for future longitudinal studies, potentially utilizing prospective diaries to reduce recall issues, which would allow for tracking headache burden and fertility intentions over time and exploring potential causal links. Such studies should incorporate clinical validation of headache diagnoses.

Third, the response rate was relatively low (21.6%), which may have introduced selection bias and raised concerns about non-response bias. It is possible that individuals with severe headaches were more or less likely to participate, depending on their current condition, level of concern, or psychological burden. Conversely, individuals with mild headaches or no interest in family planning or fertility intention may have ignored the survey. Additionally, socioeconomic and family-related circumstances may have influenced response behavior. These factors may limit the generalizability of our findings. To mitigate such biases in the future, studies should aim for higher response rates, potentially through strategies such as employing broader recruitment channels.

Fourth, our investigation did not delve into the complex decision-making process that led individuals with headaches to proceed with pregnancy despite initial hesitation. Future research would significantly benefit from qualitative interviews or detailed surveys to understand the specific factors that enabled or motivated them to overcome their concerns, such as effective treatment,

social support, personal values, or unplanned pregnancies [48]. Furthermore, we did not account for crucial socioeconomic factors like occupation, household income, educational level, and employment status, which may significantly influence fertility intentions [49] and interact with headache-related variables. Addressing these gaps through future social surveys and in-depth investigations into the underlying reasons for pregnancy through qualitative interview will provide a more comprehensive understanding of reproductive decisions in this population.

Finally, all responses were self-reported and may be subject to recall bias. In addition, the relatively small number of participants in the avoid pregnancy group ($n = 22$) limits the statistical power of the analysis. Moreover, the effect sizes observed in the univariable analyses were relatively small. Therefore, our findings should be interpreted with caution and validated in larger, prospective studies. Despite these limitations, this study provides novel insights into the relationship between headache disorders and reproductive decision-making in a general population setting.

Conclusions

We conducted a prospective school-based online survey targeting parents who experience headaches. Among the 599 participants, 562 (93.8%) reported no impact on their pregnancy plans, while 22 (3.7%) indicated that they were avoiding or avoided pregnancy. Those in the avoid pregnancy group were older, had shorter headache duration, a greater MHD, and were more likely to report symptoms such as nausea or vomiting and phonophobia. They tended to have a greater burden of headaches. They also felt disability-related concerns about pregnancy and parenting, as well as concerns regarding the negative impact of headache medications on child development. Consequently, further research to elucidate the relationship between headaches and fertility intentions and enhanced public awareness of appropriate knowledge on the relationship between headache disorders and pregnancy are warranted. Additionally, longitudinal studies evaluating the effects of awareness campaigns and clinical interventions on headache disorders, fertility intentions, and national birthrates in Japan are warranted. From a clinical perspective, our findings highlight the importance of tailored support for women with a significant headache burden, particularly those with sensory hypersensitivities, who may be more vulnerable to anxiety and pregnancy avoidance. Clinical recommendations include routine headache burden screening during preconception care, interdisciplinary collaboration between neurology and reproductive health providers, and the development of decision aids and cognitive-behavioral interventions to address anticipatory anxiety. Moreover, public education initiatives to correct misconceptions about medication safety during pregnancy may reduce unnecessary reproductive hesitation. Together, these strategies may help support informed reproductive decision-making and mitigate the broader societal impact of headache disorders.

Study Highlights

1. We prospectively performed a school-based online survey of 5227 students' households and retrieved 599 (11.5%) responses from parents with headaches.
2. Among the female respondents, 22/562 (3.9%) answered that they were avoiding, or they had avoided pregnancy due to headaches (avoid pregnancy group).
3. The avoid pregnancy group was older, had shorter headache duration, a greater MHD, and were more likely to report symptoms such as nausea or vomiting and phonophobia.

Abbreviations

AMD	Monthly acute medication intake days
CGRP-mAbs	Monoclonal antibodies targeting calcitonin gene-related peptide
CI	Confidence interval
HIT-6	Headache Impact Test-6
ICHD-3	The International Classification of Headache Disorders, 3rd edition
MHD	Monthly headache days
MIBS-4	Migraine Interictal Burden Scale-4
MOH	Medication-overuse headache
NSAIDs	Non-steroidal anti-inflammatory drugs
OR	Odds ratio
TACs	Trigeminal autonomic cephalalgias
TTH	Tension-type headache

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s10194-025-02100-5.

Supplementary Material 1.

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Authors' contributions

MK, SO, and KM. wrote the main manuscript text and MK, MT, and KS prepared Figs. 1, 2 and 3. All authors reviewed the manuscript.

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Data availability
Data is provided within the manuscript or supplementary information files.

Declarations

Competing interests
The authors declare no competing interests.

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