

Original Research Article

Age at menarche and risk of developing migraine or non-migraine headaches by young adulthood

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ABSTRACT

Background: Menstruation plays a significant role in the onset of migraine attacks in women, particularly during reproductive years. Among menstrual factors, age at menarche appears to influence migraine prevalence. However, limited research has been conducted on this association in both national and international contexts. This study aimed to assess the relationship between age at menarche and the risk of developing migraine or non-migraine headaches in young adult women attending a tertiary care hospital. To investigate the association between age at menarche and headache type and to compare the clinical characteristics (frequency, duration and severity) of migraine and non-migraine headaches.

Methods: This observational study was conducted over two years at the Department of Neurology, Dhaka Medical College Hospital. Women aged >18 years with a history of headache and attending the “Headache Clinic” were included after obtaining informed written consent. Migraine and non-migraine headaches were diagnosed according to ICD-IIIβ criteria. An age-matched control group was also recruited. A total of 300 participants were interviewed (100 in each group: migraine, non-migraine and control). Data were analyzed using SPSS version 22.0.

Results: The mean participant age was 30.64±7.78 years. Migraine patients had an earlier mean age at menarche (12.58±1.73 years) than non-migraine (13.66±1.01) and control groups (13.19±0.73) (p<0.001). A 1-year delay in menarche reduced migraine risk by 30% but increased non-migraine headache risk by 83%. Migraineurs experienced more nausea, vomiting and photophobia (p<0.001).

Conclusions: Early menarche is associated with an increased risk of migraine in young adult women.

Keywords: Age at menarche, Logistic regression, Migraine headache, Neurology, Non-migraine headache, Risk factors, Young adulthood

INTRODUCTION

Headache refers to pain experienced in the head region, excluding the lower face but encompassing the upper neck.

It is among the most common neurological conditions and a leading reason for consultations in general medical practice. Approximately half of the global population experiences a headache at least once annually, while over

90% report having had a headache at some point in their lives.¹ The majority of headaches are harmless and not linked to serious health conditions. In fact, only about 1–5% of individuals who visit emergency departments for headache complaints are found to have a serious underlying cause.² Headaches frequently arise due to traction or irritation of the meninges and associated blood vessels. Nociceptors in these structures can be activated by factors such as head injuries or tumors, leading to headache pain. Additionally, spasms or dilation of blood vessels, inflammation or infection of the meninges and muscle tension can all trigger nociceptor stimulation, contributing to headache development.³ Headaches are generally categorized into two main types: "primary" and "secondary." Secondary headaches result from an underlying medical condition, such as infections, head trauma, vascular abnormalities, intracranial hemorrhage or brain tumors.⁴ Primary headaches include migraines, tension-type headaches, trigeminal autonomic cephalalgias (such as cluster headaches) and trigeminal neuralgia. These types account for approximately 90% of all headache cases.⁵ Migraine is a prevalent and intricate neurological disorder and is recognized as the fourth leading cause of disability worldwide.⁶ Migraine affects approximately 4.5–6% of men and 14.5–18% of women. In children and adolescents, the prevalence is around 7.7%.

Additionally, about 3% of the general population experiences chronic headaches.⁷ In the United States, approximately 6% of men and 18% of women experience migraines annually. The estimated lifetime risk is around 18% for men and 43% for women.⁸ The pathophysiology of migraine involves intricate interactions between peripheral and central mechanisms, though it remains not fully understood. Diagnostic criteria for migraine typically include a throbbing, one-sided headache that worsens with physical activity, accompanied by symptoms such as nausea, vomiting, sensitivity to light (photophobia) and sensitivity to sound (phonophobia).⁹

Non-migraine headaches are characterized by their location occurring on one or both sides of the head or in areas such as the back, front or around the eyes—and by the absence of typical migraine features. These headaches are generally non-pulsating and are not aggravated by physical activity.¹⁰ Tension headaches, which affect approximately 1.6 billion people worldwide, are believed to result from the activation of peripheral nerves in the muscles of the head and neck.¹¹

Cluster headaches are characterized by brief, intense episodes of pain lasting between 15 and 180 minutes, typically centered around one eye. These attacks are accompanied by autonomic symptoms such as tearing, redness of the eye and nasal congestion, often occurring at the same time each day. The condition is associated with overactivation of the trigeminal nerve and the hypothalamus.¹² The exact causes of migraines remain

unknown. However, migraines can be triggered by various factors, with symptoms sometimes appearing up to 24 hours after exposure to these triggers. Common triggers include hormonal fluctuations, emotional stress, physical exertion, certain dietary elements, environmental changes and specific medications.¹³ The incidence and frequency of migraines are influenced by different phases of the menstrual cycle, as well as by pregnancy, peri-menopause and menopause.¹⁴ Although migraine prevalence is similar between boys and girls before puberty, after puberty migraines become 2 to 3 times more common in females, with attacks often increasing in intensity during this period.¹⁵

Menarche, a key and easily measurable milestone in the later stages of puberty for girls, has been linked to migraine onset. Studies indicate that an earlier age at menarche is associated with a higher risk of developing migraines by young adulthood. Migraine, a common headache disorder, typically begins after menarche, tends to occur more frequently in the days leading up to or during menstruation and often improves during pregnancy and menopause.¹⁶ This scientific evidence suggests a possible link between the age at menarche and the development of migraines.

While similar studies have been conducted internationally, to the best of current knowledge, no research on this topic has been carried out within this country. Therefore, this observational study was designed to investigate the association between age at menarche and the risk of developing migraine or non-migraine headaches by young adulthood among women attending a tertiary care hospital.

Objectives

General objective

To determine the relation between age at menarche and risk of developing migraine or non-migraine headaches by young adulthood.

Specific objectives

To assess the clinical characteristics (frequency, duration and severity) of migraine and non-migraine headache patients. To determine the age of menarche in all migraine and non-migraine headache patients and control patients. To observe the relation between age of menarche and development of migraine. To assess the partial and relevant (age, socioeconomic level, educational qualification, marital status) socio-demographic characteristics of the respondents.

METHODS

Study design

This observational hospital-based study was conducted at the Headache Clinic of the Department of Neurology,

Dhaka Medical College and Hospital, Dhaka, over a period of two years from January 2017 to December 2018. The study population comprised three groups: Group A included women aged over 18 years with migraine headache; Group B included women aged over 18 years with headache other than migraine; and Group C consisted of apparently healthy women aged over 18 years without headache, preferably attendants of the patients.

Sample size

The sample size of this study was determined by following equation.

Formula of sample size calculation: $n = (z^2 pq) / d^2$

Here,

n = sample size, $z = 1.96$, p = Prevalence: 29.7%, $q = 1 - p$ and d = allowable error: 5% (0.05).

Total study subjects: $= (1.96)^2 \cdot 0.297(1-0.297) / (0.05^2) = 320$

Considering limitation of time, logistic support and lack of sufficient fund 100 samples in each group were considered for final analysis.

Sampling technique

Non-randomized purposive sampling technique was used.

Inclusion criteria

Women aged above 18 years were eligible to participate in the study. Participants were divided into three distinct groups based on their clinical presentation. Group A included women diagnosed with migraine according to the International Classification of Headache Disorders, 3rd edition (beta version) (ICHD-III beta) criteria. Group B comprised women suffering from headache disorders other than migraine, while Group C involved apparently healthy women with no history of headache disorders. All participants in the three groups were required to provide informed written consent prior to enrolment in the study.

Exclusion criteria

Women with a known history of secondary headache disorders, such as those due to head trauma, infections, vascular diseases or tumors, were excluded from all three groups. This criterion was implemented to ensure that only primary headache disorders were evaluated. Additionally, individuals with any systemic illness or neurological condition that could confound the study results were also excluded. Participants who declined to provide informed consent or were unable to comply with study protocols were not included in the final analysis.

Data collection procedure

Ethical approval was obtained from the Ethical Review Committee of DMC before initiating the study. Women attending the headache clinic with headache disorders were recruited, while apparently healthy adult female attendants were enrolled as controls. Based on the ICHD-III (beta) criteria, participants were categorized into three groups: Group A (women >18 years with migraine), Group B (women >18 years with non-migraine headache) and Group C (apparently healthy women >18 years without headache). After obtaining informed written consent, each participant underwent history taking and physical examination.

A structured questionnaire was used by the principal investigator to collect data on demographics (age, marital status, education, socioeconomic status) and migraine risk factors (age at menarche, obesity, smoking, OCP use, diet, exercise). Age was confirmed through birth date records, national ID or relevant historical references. Participants were selected sequentially and those unwilling or providing incomplete data were excluded and replaced.

Data analysis

Data were collected, tabulated and analyzed statistically using an IBM personal computer and the statistical package SPSS version 22 (Chicago, Illinois, USA). Two types of statistics were calculated: descriptive (e.g. percentage (%), range, mean and SD) and analytical. Besides these, logistic regression analysis were considered to determine factors associated with migraine incidence. In necessary cases, chi-square test or student's t test or non-parametric test were used to established the association. Whole data analysis was done with 95% confidence interval and 5% error. Moreover, $p < 0.05$ was considered as a value of significance.

Ethical consideration

The researcher ensured strict adherence to ethical principles throughout the study. Formal ethical clearance was obtained from the ethical review committee of Dhaka Medical College before conducting the research. Confidentiality of participants and their information was strictly maintained, with no unauthorized access to the data. Informed written consent was obtained from all participants after explaining the study's nature, purpose and procedures. They were also informed of their right to refuse, accept or withdraw from participation at any stage. Additionally, it was made clear that participants would not receive any financial benefits from the study, ensuring voluntary and unbiased participation.

RESULTS

Table 1 presents the sociodemographic profile of the respondents. The mean age was 30.64 ± 7.78 years, with the majority (42.7%) aged between 21–30 years. Most

participants were from urban areas (57.7%), while 42.3% were from rural settings. Educationally, 48% had completed or were pursuing graduation and above, followed by HSC (28.3%), SSC (13%), primary education (6%) and 4.7% were illiterate. Socioeconomically, 62.3% belonged to the middle class, 20% to the upper class and 17.7% to the lower class. The majority were married (72.7%), while 27.3% were unmarried. Distributions were comparable across groups.

Figure 1 illustrate a total 300 participants were included in the study. Among them 100 patients (33.33%) had migraine, 100 patients (33.33%) had headache other than migraine and another 100 patients (33.34%) were age matched control. For the ease of description headache other than migraine patients will be designated as Other Headache group. Table 2 shows that most respondents (92.3%) led a sedentary lifestyle and reported no or irregular exercise, with no significant differences across groups ($p>0.05$). Overweight status ($BMI>25$) was slightly higher in the migraine group (19%) than in other headache (15%) and control groups (13%), but not statistically significant ($p>0.05$). However, a family history of migraine was significantly more common in the migraine group (19%) compared to the control (2%) and other headache group (0%) ($p<0.001$).

Table 3 shows that Nausea, vomiting and photophobia was significantly more common in migraine patients in comparison to other headache patients ($p<0.001$). Phonophobia and aura were exclusively associated with migraine and scalp tenderness and giddiness were exclusively associated with other headaches. Table 4 shows the majority of the migraine patients complained of moderate pain (61%) and majority of other headache patients complained mild pain (59%). The difference was statistically significant ($p<0.05$). Table 5 shows that Majority patients among both migraine group (38%) and other headache group (50%) had headache for more than 3 years ($p>0.05$). Duration of attack was 4–72 hours in 68% patients of migraine group and was <4 hour in 32% of migraine group. Also, it was 4–72 hours in 22% patients of other headache group and was >72 hours in 78% of others headache group. Mean attack frequency was

4.93 ± 1.63 per month in migraine group and 10.14 ± 5.52 per month in other headache group.

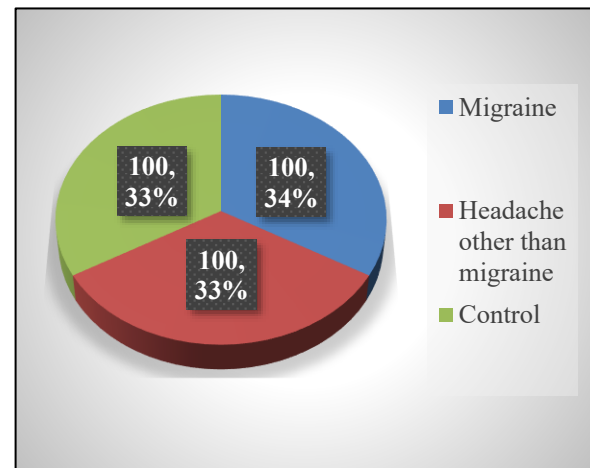


Figure 1: Distribution of participants according to their category (n=300).

Table 6 shows Mean age at menarche was 12.58 ± 1.73 years in migraine group, 13.66 ± 1.01 in other headache group and 13.19 ± 0.73 in control group. ANOVA shows that mean age at menarche differed significantly among groups ($p<0.001$). Post-hoc analysis shows that migraine patients had significantly lower mean age at menarche than that of other headache group and control group ($p<0.001$ and $p=0.002$, respectively). Other headache patients had significantly higher mean age at menarche than control group.

Table 7 shows that Logistic regression analysis showed that 1 year delay in menarche was significantly associated with 30% decrease in odds of developing migraine. When adjusted for BMI and family history of migraine, the OR retained its significance. Table 8 shows that Logistic regression analysis showed that 1 year delay in menarche was significantly associated with 83% higher odds of developing another headache than migraine. When adjusted for BMI and family history of migraine, the OR retained its significance.

Table 1: Socioeconomic data distribution of respondents (n=300).

Socioeconomic data	Migraine (n=100)	Other headache (n=100)	Control (n=100)	Total (n=300)
Age (in years)	%	%	%	N (%)
18–20	6	5	6	17 (5.7)
21–30	45	41	42	128 (42.7)
31–40	38	44	39	121 (40.3)
41–50	11	10	13	34 (11.3)
Mean±SD	29.51±7.38	31.11±7.68	31.32±8.22	30.64±7.78
Residence				
Urban	61	47	65	173 (57.7)
Rural	39	53	35	137 (42.3)
Education				
Illiterate	7	3	4	14 (4.7)

Continued.

Socioeconomic data	Migraine (n=100)	Other headache (n=100)	Control (n=100)	Total (n=300)
Primary	4	5	9	18 (6)
SSC	6	20	13	39 (13)
HSC	37	22	26	85 (28.3)
Graduate and above	46	50	48	144 (48)
Economic class				
Lower class	13	21	19	53 (17.7)
Middle class	71	57	59	187 (62.3)
Upper class	16	22	22	60 (20)
Marital status				
Married	65	77	76	218 (72.7)
Unmarried	35	23	24	82 (27.3)

Table 2: Distribution of respondents according to risk factors associated with headache (n=300).

Risk factors	Migraine (n=100)	Other headache (n=100)	Control (n=100)	P value
	%	%	%	
Sedentary lifestyle	91	94	92	0.719
Irregular/no exercise	90	96	91	0.232
BMI (≥ 25 kg/m ²)	19	15	13	0.493
OCP intake	22	16	15	0.373
Family history of migraine	19	0	2	<0.001

P value determined by Chi-square test.

Table 3: Distribution of respondents according to clinical features associated with headache (n=200).

Clinical features	Migraine (n=100)	Other headache (n=100)	P value
	%	%	
Nausea	84	16	<0.001
Vomiting	62	8	<0.001
Photophobia	23	3	<0.001
Phonophobia	6	0	0.002
Aura	6	0	0.002
Scalp tenderness	0	13	<0.001
Giddiness	0	10	<0.001

P value determined by Chi-square test, *multiple response.

Table 4: Distribution of patients according to severity of headache (n=200).

Headache severity	Migraine (n=100)	Other headache (n=100)	P value
	%	%	
Mild (NRS 1–3)	33	59	0.001
Moderate (NRS 4–6)	61	37	
Severe (NRS 7–10)	6	4	

P value determined by the Chi-square test.

Table 5: Distribution of patients according to duration and frequency of headache (n=200).

Duration of headache	Migraine (n=100)	Other headache (n=100)	P value
	%	%	
Duration of disease (in years)			
<1	26	23	0.212*
1–3	36	27	
>3	38	50	
Duration of each attack (in hours)			
<4	32	0	<0.001*
4–72	68	22	

Continued.

Duration of headache	Migraine (n=100)	Other headache (n=100)	P value
	%	%	
>72	0	78	
Attack frequency per month			
Mean±SD	4.93±1.63	10.14±5.52	<0.001**

P value determined by Chi-square test* and independent samples t test**.

Table 6: Distribution of patients according to age at menarche (n=300).

Age at menarche	Migraine (n=100)	Other headache (n=100)	Control (n=100)	P value
Mean±SD (years)	12.58±1.73	13.66±1.01	13.19±0.73	<0.001 [†]
	12.58±1.73	13.66±1.01	-	<0.001*
	12.58±1.73	-	13.19±0.73	0.002**
	-	13.66±1.01	13.19±0.73	0.022***

[†]P value determined by ANOVA. *,** and ***Post-hoc test was done using Bonferroni method.

Table 7: Logistic regression showing relationship of age at menarche with development of migraine.

Age at menarche	Odds ratio (OR)	95% CI	P value	
Univariate regression	0.700	0.557	0.879	0.002
Multivariate regression (Adjusted for BMI and family history of migraine)	0.659	0.514	0.846	0.001

Table 8: Logistic regression showing the relationship of age at menarche with development of headaches other than migraine.

Age at menarche	Odds ratio (OR)	95% CI	P value	
Univariate regression	1.83	1.308	2.571	<0.001
Multivariate regression (Adjusted for BMI and family history of migraine)	1.88	1.337	2.665	<0.001

DISCUSSION

The present study found that the mean age at menarche was significantly lower in migraine patients (12.58±1.73 years) compared to other headache (13.66±1.01 years) and control groups (13.19±0.73 years) ($p<0.001$). Post-hoc analysis confirmed that migraineurs had an earlier menarche than both other headache patients and controls. These findings align with previous studies suggesting that early menarche is a risk factor for migraine. A study by Stewart et al, reported that women with migraine had a significantly earlier menarche (12.5 years) compared to non-migraineurs (13.1 years), supporting the hypothesis that early estrogen exposure may contribute to migraine pathophysiology.¹⁷

Logistic regression analysis in our study revealed that a one-year delay in menarche was associated with a 30% reduction in the odds of developing migraine ($p<0.001$). This association remained significant even after adjusting for BMI and family history of migraine. Similar findings were reported by Aegidius et al, who found that each year of delayed menarche decreased the risk of migraine by 7% in a large population-based study.¹⁸ The protective effect of later menarche may be linked to a more gradual exposure to estrogen fluctuations, reducing susceptibility to migraine. Conversely, our study found that delayed

menarche was associated with 83% higher odds of developing non-migraine headaches compared to migraine ($p<0.001$). This suggests that different headache types may have distinct hormonal risk factors. A study by MacGregor et al, observed that tension-type headaches were more common in women with later menarche, possibly due to different neuroendocrine mechanisms compared to migraine.¹⁹ The higher prevalence of nausea, vomiting and photophobia in migraine patients ($p<0.001$) further supports the distinct clinical profile of migraine compared to other headache types. Phonophobia and aura were exclusively associated with migraine, while scalp tenderness and giddiness were more common in non-migraine headaches. These findings are consistent with the diagnostic criteria established by the international classification of headache disorders (ICHD-3).²⁰ Family history of migraine was significantly more common in migraine patients (19%) than in controls (2%) ($p<0.001$), reinforcing the role of genetic predisposition in migraine. A meta-analysis by Mulder et al. reported a 1.9-fold increased risk of migraine in individuals with a positive family history, highlighting the strong hereditary component.²¹

The majority of migraine patients reported moderate pain (61%), while non-migraine headache patients predominantly reported mild pain (59%) ($p<0.05$). This

aligns with prior research by Lipton et al, who found that migraine pain intensity is typically moderate to severe, whereas tension-type headaches are often milder.²² Our study also noted that most migraine patients (68%) had headache durations of 4–72 hours, whereas non-migraine headaches lasted >72 hours in 78% of cases. The mean attack frequency was higher in non-migraine headaches (10.14±5.52/month) compared to migraine (4.93±1.63/month). These findings are consistent with a study by Bigal et al, which reported that chronic tension-type headaches often have higher frequency but shorter duration per attack compared to episodic migraine.²³ Sedentary lifestyle and lack of exercise were common across all groups (92.3%), with no significant differences ($p>0.05$). However, migraine patients had a slightly higher prevalence of overweight status (19%) compared to other groups. A similar trend was observed in a study by Peterlin et al, who found that obesity was associated with increased migraine frequency, possibly due to inflammatory mechanisms.²⁴

This study was limited to a single-center sample, which may affect the generalizability of the results. Genetic influences on migraine were not assessed, despite their known role in its pathogenesis. Additionally, the study did not consider the impact of hormonal factors, which are closely linked to migraine in women.

CONCLUSION

In conclusion, age of menarche was significantly earlier in migraine group than others. In addition, considering other factors in analysis it was revealed that early age of menstruation leads to migraine headache significantly in later life. Therefore, early age menarche could be a risk factor and predictor of migraine development in women.

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