Research Article

Association of Delayed Sleep Onset With Increased Migraine Frequency: A Cross-Sectional Clinical Study

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Abstract

Migraine is a recurrent neurological disorder that can substantially affect daily functioning and is frequently accompanied by disturbances in sleep. Growing evidence suggests that sleep and migraine are closely interconnected; however, the contribution of specific sleep characteristics, particularly difficulty initiating sleep, to migraine frequency requires further clarification. This study investigated the relationship between sleep characteristics and migraine frequency, with particular emphasis on sleep-onset latency, while also examining relevant demographic, clinical, and migraine precipitating factors. A cross-sectional observational study was conducted among 55 patients with migraine, classified into ≤3-days and >3-days migraine-frequency groups. Information on demographic and clinical characteristics, sleep patterns, and migraine precipitating factors was analyzed using descriptive and inferential statistics, correlation analysis, and multivariable logistic regression. Participants with higher migraine frequency demonstrated significantly longer sleep-onset latency. Prolonged sleep-onset latency was significantly associated with higher migraine frequency and remained independently associated after adjustment for age and sex. A significant positive correlation was also observed between sleep-onset latency and migraine-frequency category. Conversely, total sleep duration, habitual bedtime and wake-up time, daytime tiredness, history of insomnia, afternoon napping, demographic and clinical characteristics, and migraine precipitating factors were not significantly associated with migraine frequency. The findings identify prolonged sleep-onset latency as the principal sleep-related characteristic associated with higher migraine frequency. Routine assessment of difficulty initiating sleep may therefore complement the clinical evaluation of patients with migraine. Prospective studies are needed to determine the temporal and causal nature of this association and its potential therapeutic relevance.

Keywords: Migraine; Migraine frequency; Sleep-onset latency; Sleep disturbance; Sleep duration; Sleep patterns; Insomnia.

Introduction

Migraine is a complicated neurological condition characterised by frequent headache attacks that can be accompanied by nausea, light and sound sensitivity, and interference with day-to-day activities. Migraine is a sensory processing disease, not only a headache, heightened neuronal excitability, autonomic regulation and biological rhythms. Therefore, focus has been placed on the factors in a person's behavior and physiology that could be modified to affect migraine occurrence. Sleep is especially relevant in this context since sleep–wake regulation and migraine seem to share several neurobiological pathways. Circadian misalignment may contribute to increased susceptibility to headache via sleep timing, hormonal regulation, and/or neuronal regulation, and headache may disrupt normal sleep patterns (Ong et al., 2018; Baksa et al., 2019). The periodic occurrence of migraine can significantly impact on work, school, social and daily activities. When attacks are frequent, clinical burden may become more significant as more frequent attacks can lead to greater functional disruption and the need for clinical management. Therefore, the identification of potentially modifiable factors associated with frequent migraine (FM) is clinically relevant. It is important to note that sleep distrubances are common in those with migraine and can be a factor influencing headache variations (Rains, 2018; Waliszewska-Prosół et al., 2021).

There is a complex and possibly two-way relationship between sleep disturbances and migraine. People who suffer from migraine can have trouble falling asleep, poor sleep quality or sleep disturbances, daytime fatigue, irregular sleep patterns, and symptoms associated with insomnia. However, sleep disorders can impact mechanisms that may contribute to the onset or vulnerability to migraines. Tiseo et al. (2020) performed a systematic review that showed significant overlap between migraine and some sleep disorders, and thus, the authors suggest that sleep is an important parameter to be considered when evaluating migrain. Likewise, Fernández-de-las-Peñas et al. (2018) noted sleep impairments in people with migraine and other primary headache conditions. Youth are not spared of sleep problems either, and Voci et al. (2021) identified significant sleep issues among adolescents and children with migraine. The suggestion of sleep and migraine may go beyond the diagnosis of sleep disorder. There may be some relationships between differences in the way people sleep and differences in migraine occurrence. While there is no direct evidence to support this, there is some prospective data indicating that sleep quality and fragmentation might be linked to migraine risk (Bertisch et al., 2020). This relationship can also be attributed to circadian timing as migraine has been linked to chronotype and attack onset timing (Van Oosterhout et al., 2018; Baksa et al., 2019). Additionally, Gelfand et al. (2021) demonstrated a link between later school start times and decreased migraine frequency in adolescents, suggesting that sleep opportunity and sleep scheduling may be pertinent to migraine burden.

The length of time it takes to fall asleep, or sleep-onset latency (SOL), is a useful indicator of sleep onset issues. However, the sleep latency period may signal sleep dysregulation even if the amount of sleep is relatively normal. This distinction is crucial since an exclusive emphasis on the amount of sleep can mask sleep initiation problems. Insomnia symptoms and sleep initiation issues have been gradually identified and recognised as clinically relevant in migraine populations (Rains, 2018; Daou & Vgontzas, 2024). Biological timing and the sleep-wake cycle (Ong et al., 2018) could also influence delayed sleep initiation and migraine susceptibility, resulting in further effects of circadian dysregulation. Other factors to be taken into account in the sleep assessment of migraine include sleep time, bedtime and wake-up time, daytime sleepiness, insomnia and napping. Different aspects of sleep are reflected in these characteristics and may not show the same relationship with migraine. For instance, sleep duration is not the sole determinant of the sleep–migraine relationship, since sleep quality and sleep fragmentation may offer more information (Bertisch et al., 2020). Likewise, chronotype and circadian timing differences indicate that the timing of sleep might be important as well as the duration of sleep (Van Oosterhout et al., 2018). Therefore, studying several sleep parameters together can help to gain a more comprehensive view into the sleep-migraine association.

Although there is much evidence linking migraine to sleep disruptions, it is unclear whether aspects of sleep are more closely associated with the frequency of migraine attacks. The literature on this topic has often been restricted to specific clinical groups, sleep disturbances, sleep quality, circadian rhythms, and/or specific sleep characteristics (Tiseo et al., 2020; Waliszewska-Prosół et al., 2021; Daou & Vgontzas, 2024). In particular, the role of sleep onset latency as compared to sleep time, sleep timing, daytime tiredness, insomnia and napping merits further study. Measuring easily quantifiable sleep parameters may help determine which sleep parameters are most important in determining migraine frequency. Sleep-onset latency can be easily clinically evaluated, and is one of the factors that may be modified in sleep behavior. A multi-paradigm assessment of sleep parameters (total sleep time, sleep timing, daytime symptoms, sleep regularity, and others) enables the relationship among the delayed sleep onset and migraine frequency to be understood in the context of a general sleep profile. This evidence can be used to tailor sleep assessment for migraine management. In order to investigate the relationship between migraine frequency and sleep characteristics, the current study focused on sleep-onset latency.

Study Objectives

1.To compare sleep-onset latency and other sleep characteristics between participants with ≤3 days and >3 days of migraine.

2.To determine the association between prolonged sleep-onset latency and higher migraine frequency.

3.To evaluate the relationships of demographic, clinical, and migraine precipitating factors with migraine frequency.

2. Methodology

2.1 Study Design

To determine the relationship between migraine frequency and sleep characteristics, cross-sectional observational research was conducted. In particular, the frequency of migraine incidence was examined in relation to sleep-onset latency, length, timing, and other sleep characteristics.

2.2 Study Setting and Population

The study involved 55 subjects with migraine, ages 15-72 years old, which consisted of both male and female subjects. Demographic data, clinical, migraine, and sleep parameters were assessed in all subjects. According to migraine frequency, subjects were classified into 2 groups: ≤3 days of migraines (n=33), and >3 days of migraines (n=22).

2.3 Sample Size and Sampling Method

The final number of samples was 55 people. Individuals who met the study criteria were selected through convenience sampling. Further classification of the study participants was based on the frequency of migraine occurrence so as to be able to compare sleep and clinical features between the two groups.

2.4 Eligibility Criteria

Participants who were diagnosed with migraines and had data regarding their demographics, clinical features, frequency of migraines, and sleep were selected for the study. Participants who lacked important data that could help in the analysis of the study were omitted from the investigation.

2.5 Procedure of Data Collection

Information about the patients was obtained through the use of a systematic method of recording data about their medical history. Information included age, gender, occupation, migraine attack frequency, sleep time, wake time, sleeping time, sleep latency, day fatigue, insomnia, afternoon naps, and triggers for the migraine attacks among others.

2.6 Study Variables

Migraine frequency was the main dependent variable and divided into categories of ≤3 days and >3 days. Sleep factors include sleep latency, sleep duration, bed time, wake time, daytime fatigue, insomnia, and afternoon naps. Demographic factors include age, gender, and occupation, while clinical factors include hypertension, diabetes mellitus, and other co-morbid conditions. The precipitating factors for migraine include light, sound, heat, cold, and others.

2.7 Data Processing and Statistical Analysis

The collected data were coded, cleaned, and analyzed using descriptive and inferential statistical methods. Continuous variables were summarized as mean ± standard deviation (SD), while categorical variables were expressed as frequency and percentage. Differences in continuous variables between the ≤3-days and >3-days migraine groups were assessed using the independent-samples t-test, while categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. Correlation analysis was performed to examine the direction and strength of relationships between sleep characteristics and migraine frequency. The relationship between extended sleep-onset latency and increased migraine frequency was examined using binary logistic regression analysis. The results were presented as adjusted odds ratios (ORs) with 95% confidence intervals (CIs) using a multivariable model that took sex and age into account. Every test was two-tailed, and statistical significance was defined as $p < 0.05$.

3. Results

3.1 Demographic and Clinical Features

The frequency of migraines was used to compare the patients' clinical characteristics and demographics. While the two migraine frequency groups were similar in terms of age, gender, and other medical problems, the majority of the sample population was female (Table 1).

Table 1. Demographic and Clinical Features According to Migraine Frequency

Characteristic	Overall (N=55)	≤3 days (n=33)	>3 days (n=22)	p-value
Age (years), mean ± SD	32.89 ± 13.51	31.21 ± 12.32	35.41 ± 15.06	0.284
Female, n (%)	42 (76.4)	26 (78.8)	16 (72.7)	0.604
Male, n (%)	13 (23.6)	7 (21.2)	6 (27.3)	0.604
Hypertension, n (%)	6 (10.9)	2 (6.1)	4 (18.2)	0.204
Type 2 diabetes, n (%)	2 (3.6)	1 (3.0)	1 (4.5)	1.000
Other comorbidities, n (%)	11 (20.0)	7 (21.2)	4 (18.2)	1.000

SD: standard deviation.

None of the clinical or demographic factors examined in relation to migraine frequency showed statistically significant differences. Figure 1 shows that those in the >3-days group were generally older than those in the ≤3-days group, but this difference was not statistically significant.

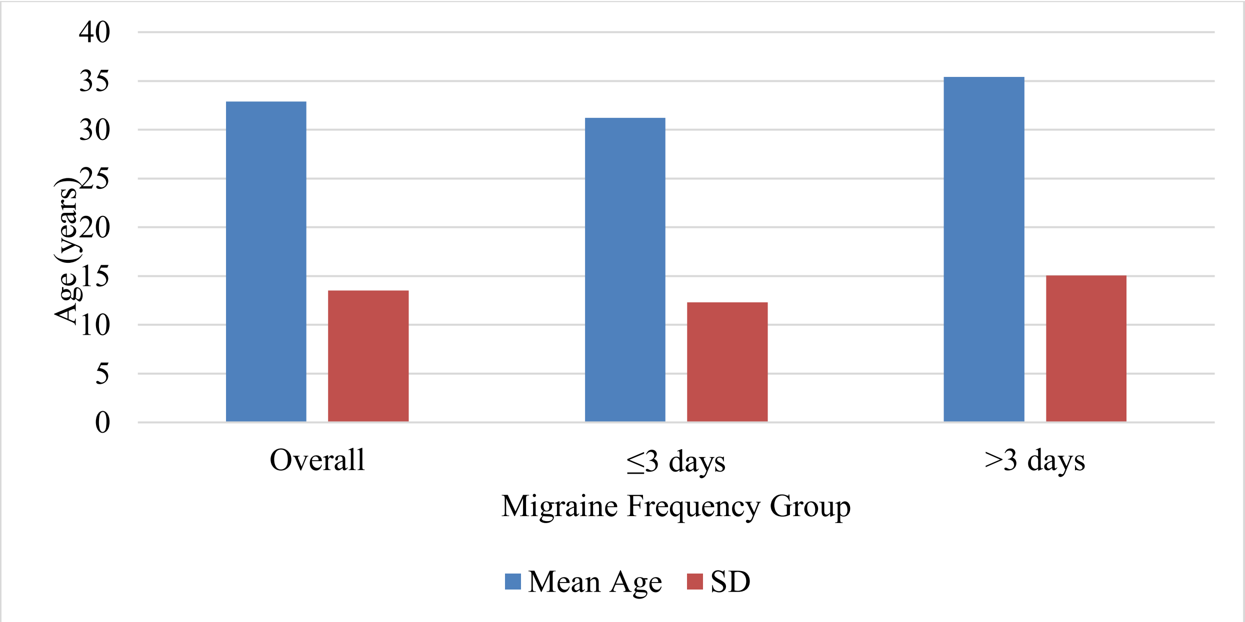

Figure 1. Mean Age of Participants According to Migraine Frequency Group

As is seen in Figure 1 below, the age profile was relatively similar among all the categories of migraine frequency.

The slight rise in average age in the >3-days category does not reflect any correlation between age and migraine frequency.

3.2 Sleep Characteristics According to Migraine Frequency

Migraine frequency was compared between groups with respect to sleep features such as the ability to fall asleep, sleep time, time of going to sleep, and any symptoms. There is a significant alteration in sleep-onset latency among the groups, while other sleep features were the same (Table 2).

Table 2. Sleep Characteristics According to Migraine Frequency

Sleep characteristic	≤3 days (n=33)	>3 days (n=22)	p-value
Sleep-onset latency (min), mean ± SD	31.06 ± 31.12	57.50 ± 50.70	0.036
Sleep-onset latency (min), median	15	30	0.033
Total sleep duration (h), mean ± SD	6.76 ± 1.31	6.18 ± 1.48	0.147
Mean bedtime	22:15	22:11	0.805
Mean wake-up time	05:28	05:16	0.519
Daytime tiredness, n (%)	17 (51.5)	13 (59.1)	0.580
Afternoon napping, n (%)	20 (60.6)	14 (63.6)	0.821
History of insomnia, n/N (%)	5/32 (15.6)	2/21 (9.5)	0.690

The time taken to fall asleep was significantly higher in those who suffered more migraines. On the other hand, total sleep time, bed time, waking time, feeling drowsy during the day, afternoon sleeping habits, and previous insomnia had no significant differences.

3.3 Association Between Prolonged Sleep-Onset Latency and Migraine Frequency

The sleep onset latency measure was then classified by a clinically interpretable cut point to see if a longer time for sleep onset was related to migraine frequency categories. This is represented in Table 3 below.

Table 3. Association Between Prolonged Sleep-Onset Latency and Migraine Frequency

Sleep-onset latency	≤3 days, n (%)	>3 days, n (%)	OR (95% CI)
<30 min	19 (57.6)	6 (27.3)	1.00 (Reference)
≥30 min	14 (42.4)	16 (72.7)	3.62 (1.13–

			11.60)

OR: odds ratio; CI: confidence interval. Overall association: p = 0.027.
Increased sleep latency duration was statistically significant in relation to increased frequency of migraines. People with late onset of sleep were more likely to fall into the group with higher migraine frequency.

3.4 Correlation Between Sleep Characteristics and Migraine Frequency

To determine the type and degree of association among the primary sleeping parameters and the frequency of migraine, correlation analysis was carried out. The findings are shown in Table 4 below.

Table 4. Correlation Between Sleep Characteristics and Migraine Frequency

Sleep characteristic	Correlation coefficient (r)	p-value
Sleep-onset latency	0.313	0.020
Total sleep duration	-0.204	0.135
Bedtime	-0.035	0.801
Wake-up time	-0.086	0.531

A positive relationship was found between sleep onset latency and the frequency of migraines, while total sleep duration had a weak negative association. Bedtime and wake up time were not suggestively related with frequency of migraines.

3.5 Migraine Precipitating Factors

These main triggering factors for migraines were assessed using migraine frequency categories. The distribution of the triggers – light, sound, heat, and cold – within the entire sample and the two frequency categories is shown in Figure 2.

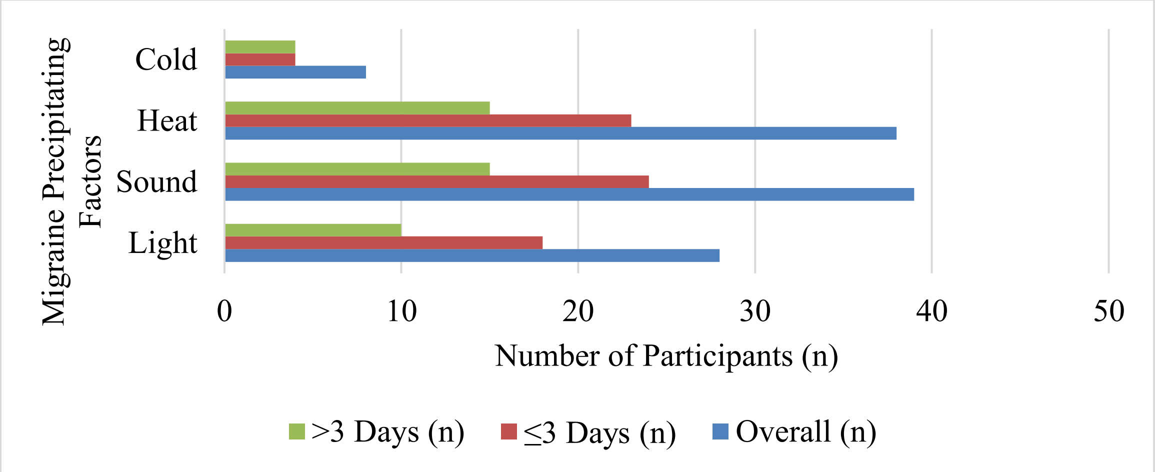

Figure 2. Distribution of Migraine Precipitating Factors According to Migraine Frequency

As shown in Figure 2, sound and heat were the most common precipitants, while cold was the least common. The trend of the precipitating factors was quite similar in both the ≤3-day and >3-days groups of migraines. While there were some differences in the trend of individual precipitating factors between the two groups, none had any statistical association with frequency of the headaches.

3.6 Multivariable Logistic Regression Analysis

Prolonged sleep onset latency as a risk factor for high frequency of migraine attacks independent of age and gender was analyzed using multivariate logistic regression analysis. Adjusted relationships are summarized in Table 5.

Table 5. Multivariable Logistic Regression Analysis of Factors Associated With Migraine Frequency >3 Days

Predictor	Adjusted OR	95% CI	p-value
Sleep-onset latency ≥30 min	3.76	1.14–12.42	0.030
Age, per year	1.03	0.98–1.07	0.228
Female sex	0.78	0.20–3.04	0.722

However, when attuned for age and sex, sleep onset latency still had significant association with increased frequency of migraines. Neither age nor sex had an independent relationship with the outcome. In sum, the outcomes displayed that delayed onset of sleep was the key sleep-related trait linked to increased frequency of migraines.

4. Discussion

In the present study, it was found that sleep onset latency is the most common sleep parameter that correlates with migraine frequency. Both higher migraine frequency groups had more severe sleep initiation difficulties, and, after being adjusted for age and sex, higher migraine frequency was independently associated with longer sleep-onset latency. Contrary, total sleep duration, bedtime, wake-up time, daytime tiredness, history of insomnia, afternoon naps, and demographic characteristics, comorbidities and migraine precipitating factors were not significantly related with migraine-frequency category. These results suggest that sleep onset is a specific aspect of sleep problems that is worth special attention when considering the impact of migraine on life quality.

The main result was the correlation between a longer sleep latency period and higher migraine frequency. Sleep habits have been previously shown to be poor in migraine sufferers in terms of reduced sleep duration and quality (Song et al, 2018). In a similar study, Duan et al. (2022) found a correlation between poor sleep quality and higher migraine burden. The present observations add to these findings, with delayed sleep initiation being potentially especially important with regard to frequency of migraine. In general, the participants who had more frequent migraine headaches had shorter duration of sleep, but this was not statistically significant. Some preliminary studies suggest that it is possible that various aspects of sleep may affect the risk of migraine in different ways (Vgontzas et al., 2020). Hence, it is important to not assume that sleep duration is a good measure of the sleep–migraine relationship.

Time of sleep and getting up and the number of migraines were also not correlated. Simple sleep timing is not necessarily reflective of underlying circadian control, however. Viticchi et al. (2019) correlated migraine characteristics with chronotype, and Im et al. (2019) showed correlations between chronotype and the timing of headache attacks. Furthermore, Gelfand et al. (2019) explored the impact of school schedule and migraine frequency in adolescents, suggesting the potential importance of sleep opportunity and schedule. The results presented here indicate that habitual sleep timing should be complemented in future research by an analysis of chronotype and

circadian regularity.
Tiredness, difficulty sleeping and afternoon sleepiness were not associated with migraine frequency. These may encompass lifestyle, work schedule, psychological state and quality of nighttime sleep. However, Lateef et al. (2019) showed a high level of co-occurrence between sleep issues and headaches in adolescents. A wide association between sleep and primary headache disorders has been reported, as sleep disturbances also have been linked to tension-type headache (Cho et al., 2019). The most important migraine precipitating factors were sound and heat, followed by light and cold but none were significantly associated with migraine frequency. Thus, specific triggers may influence the occurrence of an attack without necessarily influencing the frequency of an attack. Many behavioral and environmental exposures are associated with migraine susceptibility. There is a complex relationship between physical activity and migraine (Amin et al., 2018), and dietary factors can be potential triggers/modifiers (Razeghi Jahromi et al., 2019). The heterogeneity of migraine is further exemplified by differences in the population distribution of the factors associated with migraine (Zarea et al., 2018).
There are potentially several mechanisms that could account for the link between delayed sleep onset and frequency of migraine. Both sleep and migraine are mediated by overlapping pathways that involve regulation of arousal, circadian rhythms, neuronal excitability and pain processing. Even when sleep is hard to come by, it may affect the restorative mechanisms or the thresholds of the neurons that are important to migraine susceptibility. In support, Negro et al. (2020) showed that acute sleep deprivation resulted in more susceptibility to cortical spreading depolarization. The relationship may, however, be bidirectional, with normal sleep initiation affected by recurrent migraine. In general, the results are consistent with earlier studies, and highlight the need for attention to the various aspects of sleep. The pooled results from Song et al. (2018), Vgontzas et al. (2020), and Duan et al. (2022) all suggest that there is a link between poor sleep patterns and migraine. In this study, however, sleep-onset latency was more closely related with migraine frequency than sleep duration or sleep timing. Variations among studies may be due to the differences in population, sleep assessment, migraine definition, and analytical methods.
From a clinical standpoint, sleep onset latency can be measured simply during the standard examination of the migraine, and can be used to identify patients who have sleep problems associated with the migraine. The advantage of this study was the quantification of several sleep, demographic, clinical and precipitating factors at the same time along with adjusted analyses. The cross-sectional design does not allow one to make causal inferences, and the small sample size may reduce the power to detect weaker associations. Sleep characteristics were self-reported, and potentially relevant factors (medications, caffeine, psychological stress) were not included in the main model. However, the need for more comprehensive behavioral evaluation of the adolescent is supported by recent findings that relate stress, headache, and associated behaviors in adolescents (Soares et al., 2026). To facilitate the generalisation of the findings, larger prospective samples, objective sleep assessment, headache diaries, chronotype assessment, psychological stress measures as well as medication and lifestyle measures should be used in future studies. Longitudinal and intervention studies are especially warranted to clarify the relationship between improvement of sleep initiation and subsequent decrease in migraine frequency, and whether longer overall sleep-onset latency is a potential target for intervention or rather a marker for increased migraine frequency.

5. Conclusion

The present study highlights a substantial relationship among sleep-onset latency and the frequency of migraine episodes, suggesting that sleep onset is an important sleep-related parameter in the group with higher migraine frequency. These findings were also observed in the higher migraine-frequency group, who had a longer sleep onset latency, which persisted after accounting for the impacts of age and sex. Contrary to this, no significant association was found for total sleep time, habit of falling asleep late and getting up early, daytime sleepiness, insomnia or afternoon napping with migraine frequency. Demographic and clinical characteristics and the most important precipitating factors also failed to show significant relationships with the migraine-frequency category. The results indicate that the pattern of getting to sleep, specifically delayed sleep initiation, may be more important in relative to the frequency of migraine attacks than sleep duration or sleep timing in general. Sleep-onset latency might then be an important adjunct to the clinical examination of migraine patients. However, as a cross-sectional design, the observed relationship should be interpreted as an association, not a causal relationship. Larger prospective studies with objective sleep measures and longitudinal migraine monitoring are needed to further elucidate the direction of this association and the potential of sleep interventions to decrease migraine frequency and burden.

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