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Sleep Disturbances In School-Aged Children With Migraine: A Cross-Sectional Comparative Study Using Subjective And Objective Measures

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ABSTRACT

Background: Migraine is a prevalent neurological condition in children, often co-occurring with significant sleep disturbances. Although previous studies have explored this relationship, few have integrated both subjective and objective sleep assessments, particularly in Indian paediatric populations.

Objectives: To evaluate the pattern and severity of sleep disturbances in school-aged children with migraine using validated subjective tools and actigraphy, and to analyze their association with migraine frequency and severity.

Methods: A cross-sectional, case-control study was conducted involving 120 children aged 6–12 years: 60 with migraine (diagnosed per ICHD-3 criteria) and 60 age- and sex-matched healthy controls. Subjective sleep assessments included the Children's Sleep Habits Questionnaire (CSHQ), Paediatric Sleep Questionnaire (PSQ), and a 7-day sleep diary. A subsample (n = 30 per group) underwent actigraphy for objective sleep analysis. Headache frequency, intensity, and clinical features were documented. Statistical analyses included t-tests, Pearson correlations, and multivariate linear regression.

Results: Children with migraine had significantly higher CSHQ scores (51.2 ± 6.4 vs. 44.3 ± 4.9, $p < 0.001$), especially in bedtime resistance, sleep onset delay, and night wakings. PSQ scores were also elevated (4.3 ± 1.4 vs. 2.8 ± 1.2, $p < 0.001$), indicating increased sleep-disordered breathing. Actigraphy confirmed reduced total sleep time (7.2 ± 0.8 vs. 8.1 ± 0.6 hours, $p < 0.01$), lower sleep efficiency (84.1% vs. 91.2%, $p < 0.001$), and prolonged sleep latency. Significant correlations were found between migraine frequency and CSHQ total score ($r = 0.52$), as well as actigraphy-derived sleep measures. Migraine frequency and sleep onset delay were independent predictors of poor sleep (Model $R^2 = 0.38$, $p < 0.001$).

Conclusion: School-aged children with migraine exhibit multidimensional sleep disturbances as measured by both subjective and objective tools. Higher headache frequency is significantly associated with greater sleep impairment. These findings support routine screening for sleep issues in paediatric migraine care and highlight the potential value of targeted sleep interventions in mitigating headache burden.

Keywords: *Paediatric migraine, sleep disturbances, actigraphy, CSHQ, PSQ, sleep quality, headache frequency, sleep latency.*

1. INTRODUCTION

Migraine is one of the most prevalent neurological conditions affecting children, with estimates suggesting a prevalence of 3% to 10% in school-aged populations (1).The burden of pediatric migraine extends beyond episodic headache pain; it significantly affects academic performance, daily functioning, and psychosocial well-being. School performance is.

particularly impacted, with migraine linked to impaired concentration, absenteeism, and decreased quality of life in children and adolescents (2,3).

In recent years, the interaction between migraine and sleep disturbances has garnered increasing attention. Sleep and migraine share a complex, bidirectional relationship. Sleep disruption may serve both as a precipitating factor and a consequence of migraine attacks, mediated by overlapping neurochemical and neurophysiological pathways (4,5). Several studies have demonstrated that children with migraine commonly experience difficulties in initiating and maintaining sleep, increased nighttime awakenings, and poor overall sleep quality. These disturbances have been associated with higher headache frequency and severity, suggesting a reinforcing cycle between poor sleep and migraine symptomatology (6,7).

Despite the growing recognition of this association, most studies in the pediatric population rely heavily on subjective assessments, particularly parent-reported questionnaires. While tools like the Children's Sleep Habits Questionnaire (CSHQ) and Pediatric Sleep Questionnaire (PSQ) are validated and widely used, their reliance on parental perception introduces potential bias and limits their ability to capture the full scope of sleep architecture (7).

Meta-analytic evidence indicates that children with migraine exhibit altered sleep patterns, including reduced rapid eye movement (REM) sleep and increased sleep fragmentation, as measured by objective tools such as polysomnography and actigraphy (8).However, studies integrating both subjective and objective sleep assessments in children with migraine, especially within the Indian context, remain limited.

In addition to their diagnostic relevance, addressing sleep disturbances may have therapeutic value. Interventions targeting sleep hygiene and circadian regulation, such as melatonin supplementation, have shown promise in reducing migraine frequency and improving sleep quality in affected children (8). This underscores the importance of recognizing and managing sleep problems as a core component of paediatric migraine care.

Given this background, the present study was designed to evaluate the pattern and severity of sleep disturbances in school-aged children with migraine by integrating both subjective (CSHQ, PSQ, sleep diaries) and objective (actigraphy) sleep assessments. By comparing these parameters with those of age- and sex-matched healthy controls and analysing their associations with migraine characteristics, the study aims to contribute to a more comprehensive understanding of sleep disruption in paediatric migraine and its clinical implications.

2. METHODOLOGY

Study Design and Setting

This cross-sectional, observational, case-control study was conducted over a 12-month period from June 2024 to May 2025 in the Paediatric Neurology Outpatient Departments of two tertiary care hospitals in South India. Ethical clearance was obtained from the institutional review boards of both participating centres. Written informed consent was obtained from the parents or legal guardians of all participants, and assent was obtained from children aged seven years and older, wherever applicable.

Study Population

The study included school-aged children between 6 and 12 years. The case group comprised children diagnosed with migraine with or without aura, as per the International Classification of Headache Disorders, 3rd edition (ICHD-3). Age- and sex-matched healthy controls without any history of recurrent headaches, neurological conditions, or sleep disorders were recruited from local schools. Children were eligible if they were within the specified age range and if consent and assent were appropriately provided. Exclusion criteria included a prior diagnosis of psychiatric or neurodevelopmental disorders such as attention-deficit/hyperactivity disorder (ADHD) or autism spectrum disorder (ASD), chronic medical conditions such as epilepsy or asthma, use of sleep-altering medications, and presence of diagnosed primary sleep disorders. Children with poor oral hygiene or dental/ENT conditions that could interfere with sleep assessment were also excluded.

Sample Size Calculation

The sample size was estimated using a moderate effect size (Cohen's d = 0.5), with an alpha error of 0.05 and a power of 80%. Based on these assumptions, the minimum required sample size was calculated as 60 participants per group. Accounting for complete data availability, a total of 120 children were recruited—60 with migraine and 60 healthy controls.

Study Procedure

Children in the migraine group underwent a detailed clinical interview to assess headache-related characteristics including frequency, average duration, and intensity (measured using a Visual Analogue Scale). The presence of aura, associated symptoms such as photophobia, phonophobia, and nausea, as well as any family history of migraine among first-degree relatives, were also documented.

All participants were assessed for sleep disturbances using validated tools. Sleep quality was measured using the Children's Sleep Habits Questionnaire (CSHQ), a parent-reported instrument covering eight domains such as bedtime resistance, sleep

onset delay, night wakings, and overall sleep duration. Additionally, the Paediatric Sleep Questionnaire (PSQ) was administered to screen for symptoms of sleep-disordered breathing and parasomnias. A 7-day sleep diary was maintained by parents to capture information about bedtime, wake time, sleep latency, and night awakenings.

To complement subjective assessments, a subsample of participants (n = 30 in each group) was provided with wrist-worn actigraphy devices and instructed to wear them continuously for seven consecutive nights. Objective sleep parameters derived from actigraphy included total sleep time (TST), sleep efficiency, number of night awakenings, and sleep latency.

Data Management and Statistical Analysis

All data were anonymized and entered into Microsoft Excel before being analysed using SPSS version 26.0. Descriptive statistics were calculated for demographic and clinical variables. Independent samples t-tests and chi-square tests were used to compare continuous and categorical variables between the migraine and control groups, respectively. Pearson's correlation coefficients were computed to evaluate the association between headache frequency and sleep parameters. Multivariate linear regression analysis was performed to identify significant predictors of sleep disturbance, with CSHQ total score as the dependent variable and migraine frequency, headache intensity, sleep onset delay, and actigraphy-derived total sleep time as independent variables. Statistical significance was set at $p < 0.05$.

3. RESULTS

Table 1: Demographic and Clinical Characteristics of the Study Sample (N = 120)

Variable	Migraine Group (n = 60)	Control Group (n = 60)	p-value
Age (years), mean ± SD	9.4 ± 1.8	9.2 ± 1.6	0.48
BMI (kg/m²), mean ± SD	17.2 ± 2.3	17.4 ± 2.1	0.62
Positive family history (%)	36 (60%)	9 (15%)	<0.001
Migraine frequency/month	5.6 ± 2.1	—	—
Migraine with aura, n (%)	18 (30%)	—	—
Headache intensity (VAS)	7.3 ± 1.1	—	—

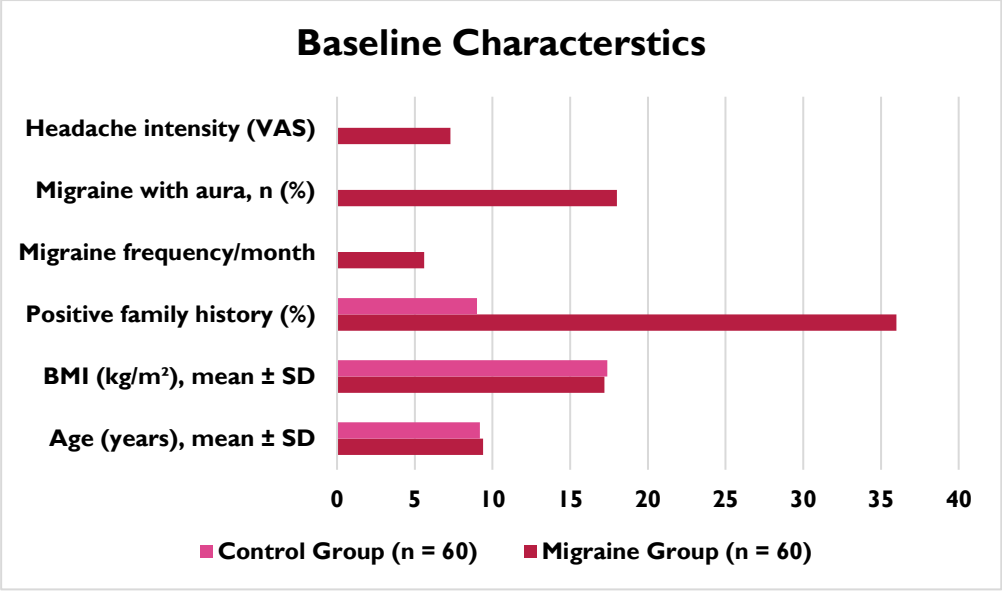

Figure 1: Baseline characterstics

This table presents the baseline characteristics of the two groups. Both groups were comparable in age, and BMI ($p > 0.05$). Children with migraine had a significantly higher positive family history of migraine (60%) compared to controls (15%, $p <$

0.001). Mean migraine frequency was 5.6 episodes/month with moderate-to-severe intensity in the majority (67%).

Table 2: Comparison of Sleep Parameters between Migraine and Control Groups

Sleep Domain (CSHQ/PSQ)	Migraine Group (mean ± SD)	Control Group (mean ± SD)	p-value
Total CSHQ Score	51.2 ± 6.4	44.3 ± 4.9	<0.001
Bedtime Resistance	10.2 ± 2.1	8.0 ± 1.5	<0.001
Sleep Onset Delay	3.1 ± 0.8	2.1 ± 0.6	<0.001
Sleep Duration	5.9 ± 1.2	4.8 ± 1.0	<0.001
Night Wakings	5.1 ± 1.0	3.7 ± 0.9	<0.001
Sleep-Disordered Breathing (PSQ)	4.3 ± 1.4	2.8 ± 1.2	<0.001

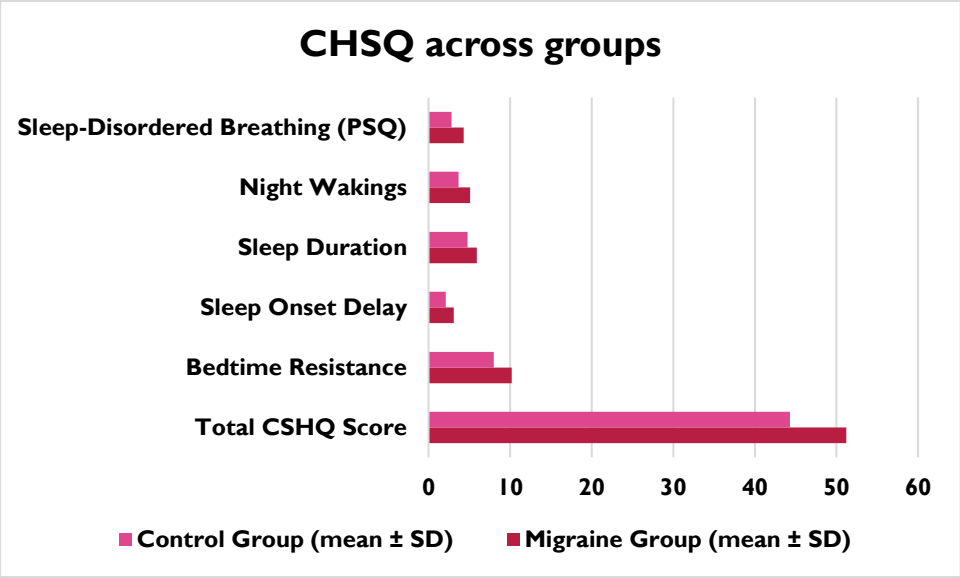

Figure 2: CHSQ across groups

This table compares sleep parameters derived from the CSHQ and PSQ. Children with migraine had significantly higher total CSHQ scores (mean = 51.2 ± 6.4) versus controls (44.3 ± 4.9, $p < 0.001$), particularly in the domains of bedtime resistance, sleep onset delay, and night wakings. PSQ scores were also elevated in the migraine group, indicating increased sleep-disordered breathing symptoms. This suggests pervasive sleep disturbances in children with migraine.

Table 3: Actigraphy-Based Sleep Measures in a Subsample (n = 60)

Parameter	Migraine Group (n = 30)	Control Group (n = 30)	p-value
Total Sleep Time (hours)	7.2 ± 0.8	8.1 ± 0.6	<0.01
Sleep Efficiency (%)	84.1 ± 5.4	91.2 ± 4.1	<0.001
No. of Night Awakenings	2.3 ± 0.9	1.1 ± 0.6	<0.001
Sleep Latency (minutes)	32.4 ± 8.6	18.7 ± 6.2	<0.001

Objective sleep data from actigraphy revealed that children with migraine had reduced total sleep time (7.2 ± 0.8 hours vs 8.1 ± 0.6 hours, $p < 0.01$) and lower sleep efficiency (84.1% vs 91.2%, $p < 0.001$). Nighttime awakenings were also more

frequent in the migraine group. These findings corroborate the subjective reports of poor sleep quality.

Table 4: Correlation between Migraine Frequency and Sleep Disturbance Scores (n = 60)

Variable	Correlation Coefficient (r)	p-value
Total CSHQ Score	0.52	<0.01
Sleep Onset Delay	0.47	<0.01
Night Wakings	0.44	<0.01
Actigraphy Total Sleep Time	-0.45	<0.01
Sleep Efficiency	-0.38	<0.01

This table shows Pearson correlation coefficients between headache frequency and various sleep indices. Significant positive correlations were noted between headache frequency and total CSHQ score ($r = 0.52$), sleep latency ($r = 0.47$), and number of night awakenings ($r = 0.44$), all $p < 0.01$. These suggest that more frequent migraines are associated with greater sleep disturbance severity.

Table 5: Multivariate Linear Regression Predicting CSHQ Total Score

Predictor Variable	β Coefficient	95% CI	p-value
Migraine Frequency	0.43	0.24 to 0.62	<0.001
Headache Intensity (VAS)	0.18	-0.01 to 0.37	0.06
Sleep Onset Delay (CSHQ)	0.39	0.19 to 0.59	<0.001
Total Sleep Time (Actigraphy)	-0.36	-0.55 to -0.17	<0.001
Model $R^2 = 0.38$; $F(4,55) = 8.31$; **p** < 0.001			

A bar graph displays the mean domain-specific scores from the Children's Sleep Habits Questionnaire across migraine and control groups. Notably, children with migraine scored significantly higher in bedtime resistance, sleep onset delay, and night waking ($p < 0.001$). Domains such as parasomnias and sleep-disordered breathing also showed elevated scores in the migraine group. The pattern suggests that migraine is associated with multidimensional sleep disruption. Error bars represent standard deviation, and asterisks denote significance.

4. DISCUSSION

This cross-sectional study assessed sleep disturbances in school-aged children with migraine using both subjective (CSHQ, PSQ, sleep diary) and objective (actigraphy) measures. The findings provide robust evidence that children with migraine experience significantly greater impairments in sleep quality and architecture compared to their healthy counterparts.

Key Findings and Interpretation

Children with migraine demonstrated significantly higher total scores on the Children's Sleep Habits Questionnaire compared to controls (51.2 ± 6.4 vs. 44.3 ± 4.9; $p < 0.001$), indicating overall poorer sleep quality. This was particularly evident in subdomains such as bedtime resistance (10.2 ± 2.1 vs. 8.0 ± 1.5), sleep onset delay (3.1 ± 0.8 vs. 2.1 ± 0.6), sleep duration (5.9 ± 1.2 vs. 4.8 ± 1.0), and night wakings (5.1 ± 1.0 vs. 3.7 ± 0.9), all with $p < 0.001$. These results are consistent with existing literature that highlights increased sleep initiation difficulties, reduced restorative sleep, and more frequent arousals in pediatric migraine populations (7) (8). Pediatric Sleep Questionnaire (PSQ) scores were also significantly elevated in the migraine group (4.3 ± 1.4 vs. 2.8 ± 1.2; $p < 0.001$), indicating a greater prevalence of sleep-disordered breathing symptoms. Although underrecognized in migraine-related studies, previous research has shown a possible link between pediatric migraine and obstructive sleep-related symptoms such as snoring and bruxism (9,10).

Objective data obtained through actigraphy further corroborated the subjective findings. Children with migraine had reduced total sleep time (7.2 ± 0.8 hours vs. 8.1 ± 0.6 hours; $p < 0.01$), lower sleep efficiency (84.1% vs. 91.2%; $p < 0.001$), prolonged

sleep latency (32.4 ± 8.6 minutes vs. 18.7 ± 6.2 minutes; $p < 0.001$), and increased nighttime awakenings (2.3 ± 0.9 vs. 1.1 ± 0.6; $p < 0.001$). These results are in line with prior actigraphic and polysomnographic studies which report altered sleep architecture, including lower REM sleep and greater sleep fragmentation in children with migraine (11).

Significant correlations were observed between headache frequency and CSHQ total score ($r = 0.52$), sleep onset delay ($r = 0.47$), night wakings ($r = 0.44$), and inverse correlations with total sleep time ($r = –0.45$) and sleep efficiency ($r = –0.38$), all $p < 0.01$. These associations demonstrate that migraine severity is linked to the degree of sleep disruption, supporting the bidirectional relationship between the two conditions (5,12).

Multivariate regression identified migraine frequency ($\beta = 0.43$; $p < 0.001$) and sleep onset delay ($\beta = 0.39$; $p < 0.001$) as significant positive predictors of overall sleep disturbance, while actigraphy-based total sleep time was an independent negative predictor ($\beta = –0.36$; $p < 0.001$). The model explained 38% of the variance in CSHQ scores ($R^2 = 0.38$; $p < 0.001$), highlighting the multifactorial contributors to sleep problems in this group.

Comparison with Existing Literature

Our findings are consistent with previous studies reporting high rates of sleep disturbances among children with migraine (6,7). A 2021 study using CSHQ found that 72.9% of pediatric migraine patients met criteria for sleep disorders, with higher headache frequency and intensity correlating with poorer sleep scores (8). Similarly, meta-analyses have confirmed altered sleep architecture in migraineurs, including reduced REM sleep and shorter total sleep duration on objective testing (10,11).

The elevated PSQ scores observed in our study align with earlier findings indicating increased sleep-disordered breathing symptoms among children with migraine (9,10). Although polysomnography remains the gold standard for diagnosing these disorders, the PSQ has demonstrated utility as a screening tool for identifying at-risk children in outpatient settings (10,11).

The results also reinforce the bidirectional nature of the migraine–sleep relationship. Sleep deprivation and poor sleep quality are known triggers for migraine attacks, while frequent migraine episodes can impair sleep through pain, anxiety, and autonomic dysregulation (12,13). Intervention studies suggest that improving sleep hygiene and treating coexisting sleep disorders can reduce migraine frequency and improve overall quality of life (7,12).

Strengths and Limitations

A major strength of this study is the concurrent use of validated subjective instruments (CSHQ, PSQ) and objective actigraphy, allowing for triangulation of findings and improved reliability. The inclusion of age- and sex-matched controls, standardized migraine diagnosis using ICHD-3 criteria, and robust statistical analysis further enhance internal validity.

Nonetheless, some limitations must be acknowledged. The cross-sectional design precludes causal inference and limits interpretation of directionality. While actigraphy offers valuable objective data, it does not assess sleep stages or diagnose specific parasomnias. The actigraphy subsample (n = 30 per group), though sufficient for comparisons, may not capture broader variability. Additionally, the sample was drawn from urban clinical and school settings, which may limit generalizability to rural or diverse socioeconomic populations.

Clinical Implications and Future Directions

Given the observed associations, routine screening for sleep disturbances should be incorporated into paediatric migraine evaluations. Validated tools like the CSHQ and PSQ can serve as efficient initial screeners in outpatient practice. Interventions targeting sleep hygiene, behavioural therapies such as cognitive behavioural therapy for insomnia (CBT-I), and management of coexisting sleep-disordered breathing may improve both sleep and migraine outcomes.

Future longitudinal and interventional studies are warranted to examine whether improving sleep quality results in better headache control. Polysomnographic studies could further elucidate specific sleep stage alterations and their relationship to migraine pathophysiology.

5. CONCLUSION

This study demonstrates that school-aged children with migraine experience significantly greater sleep disturbances compared to their healthy peers, as evidenced by both subjective (CSHQ, PSQ) and objective (actigraphy) measures. Sleep initiation difficulties, reduced total sleep time, poor sleep efficiency, and increased nocturnal awakenings were consistently observed in the migraine group. Moreover, higher migraine frequency was significantly associated with greater sleep disruption, highlighting a bidirectional and clinically meaningful relationship between headache burden and sleep quality.

The findings underscore the need for routine sleep screening in paediatric migraine evaluations and suggest that targeted interventions to improve sleep may offer dual benefits—enhancing sleep quality and potentially reducing migraine frequency and severity. Future longitudinal and interventional studies are essential to further establish causality and optimize integrated management strategies..

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