

Association of Smartphone Screen Time and Digital Device Use with Migraine Frequency and Severity in Young Adults

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Abstract

Background: Migraine is a common disabling neurological disorder among young adults and may adversely affect academic, occupational, and social functioning. Increasing dependence on smartphones and other digital devices has raised concerns regarding the potential effects of prolonged screen exposure on migraine. This study evaluated the association of smartphone screen time and digital-device use with migraine frequency and severity among young adults. **Material and Methods:** This cross-sectional observational study included 90 young adults with migraine. Sociodemographic and clinical characteristics, smartphone and total digital screen exposure, nighttime smartphone use, sleep duration, and uninterrupted screen use were recorded. Migraine frequency, headache intensity using the Visual Analogue Scale (VAS), attack duration, and migraine-related disability using the Migraine Disability Assessment (MIDAS) were assessed. Correlation and multivariable regression analyses were performed, with $p < 0.05$ considered statistically significant. **Results:** The mean age was 24.6 ± 3.5 years, and 62.2% were females. The median migraine frequency was 7 days/month, mean VAS score was 6.7 ± 1.6 , and median MIDAS score was 14. Migraine days increased from 4 among participants with < 4 hours/day of smartphone use to 9 among those with > 6 hours/day ($p < 0.001$). Correspondingly, VAS increased from 5.5 to 7.3 and MIDAS from 8 to 20 (both $p < 0.001$). Smartphone screen time correlated significantly with migraine frequency ($r = 0.52$), VAS ($r = 0.44$), MIDAS ($r = 0.47$), and attack duration ($r = 0.31$). Smartphone screen time remained independently associated with greater migraine burden ($\beta = 0.41$, $p < 0.001$). **Conclusion:** Greater smartphone and digital screen exposure was significantly associated with increased migraine frequency, severity, duration, and disability. Healthy screen-use practices may represent an important adjunct to migraine management in young adults.

Keywords: Migraine; Smartphone; Screen time; Digital devices; Young adults; MIDAS; Headache severity.

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INTRODUCTION

Migraine is a common and disabling neurological disorder characterized by recurrent episodes of headache, often accompanied by nausea, vomiting, photophobia, and phonophobia. It represents an important public health concern because of its substantial impact on academic performance, occupational productivity, social functioning, and quality of life.^[1] Young adults are particularly affected, as migraine frequently occurs during the most educationally and professionally productive period of life. Identifying potentially modifiable factors associated with migraine frequency and severity is therefore important for reducing its overall burden.^[1] The widespread adoption of digital technology has considerably transformed the daily activities of young adults. Smartphones, tablets, laptops, desktop computers, and televisions have become integral to education, employment, communication, entertainment, gaming, and social interaction. This dependence increased markedly during the COVID-19 pandemic, when online education, remote working, and restrictions on outdoor activities resulted in prolonged digital-device use.^[1] These behavioural changes may have contributed to persistent patterns of increased screen exposure, particularly among adolescents and young adults.^[2] Excessive screen time has

already been associated with adverse health outcomes, including sedentary behaviour, obesity, disturbed sleep, psychological stress, and impaired mental well-being.^[3-5] Several mechanisms may explain a possible relationship between digital-device use and migraine. Prolonged exposure to bright screens, glare, flickering visual stimuli, and short-wavelength light may precipitate headaches in susceptible individuals, particularly those experiencing migraine-related photophobia.^[6-8] Continuous near-focus activity may also cause digital eye strain, resulting in ocular discomfort, dryness, blurred vision, and visual fatigue, which may contribute to headache development.^[9] Furthermore, prolonged smartphone and computer use is often accompanied by inappropriate posture, cervical and musculoskeletal strain, reduced physical

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activity, irregular meals, and prolonged sedentary periods. Evening and nighttime screen exposure may additionally disrupt sleep and circadian rhythms, while inadequate or irregular sleep is a recognized trigger for migraine attacks. Previous studies among children, adolescents, and young adults have demonstrated associations between prolonged screen exposure and headache disorders, including migraine and tension-type headache.^[10–14] Greater duration and frequency of mobile-phone use have also been associated with increased headache occurrence. However, existing studies have several limitations, including reliance on self-reported headache symptoms, inconsistent definitions of excessive screen time, assessment of individual devices rather than cumulative digital exposure, and failure to adequately evaluate migraine-specific outcomes. Importantly, relatively limited evidence is available regarding whether smartphone screen time and overall digital-device exposure are associated with clinically relevant dimensions of migraine burden, particularly attack frequency and severity among young adults. Considering that young adults frequently use multiple digital devices throughout the day, assessment of both smartphone-specific screen time and overall digital-device use may provide a more comprehensive understanding of their relationship with migraine. Therefore, the present study aims to evaluate the association of smartphone screen time and digital device use with migraine frequency and severity in young adults.

MATERIALS AND METHODS

The present study was conducted as a hospital-based cross-sectional observational study to evaluate the association of smartphone screen time and digital device use with migraine frequency and severity among young adults. The study was conducted in department of general medicine and neurology The Study participants includes young adults presenting to the outpatient department of general medicine and neurology of Basaveshwara teaching and general hospital, Kalaburagi and KBN teaching and general hospital, Kalaburagi for duration of 6 month. Young adults presenting to the outpatient department with migraine and fulfilling the eligibility criteria were screened for participation. Migraine was diagnosed according to the International Classification of Headache Disorders, 3rd edition (ICHD-3) diagnostic criteria. A total of 90 participants with migraine were enrolled in the study. The study included a total sample size of 90 young adults with migraine. Eligible participants were recruited consecutively until the required sample size was achieved.

Study Population: Young adults presenting to the outpatient department with migraine and fulfilling the eligibility criteria were screened for participation. Migraine was diagnosed according to the International Classification of Headache Disorders, 3rd edition (ICHD-3) diagnostic criteria. A total of 90 participants with migraine were enrolled in the study. The study included a total sample size of 90 young adults with migraine. Eligible participants were recruited consecutively until the required sample size was achieved.

Inclusion Criteria

Participants were included if they:

1. were young adults aged 18–30 years;
2. fulfilled the ICHD-3 diagnostic criteria for migraine;
3. had been experiencing migraine for at least the preceding 6 months;
4. regularly used a smartphone;
5. were able to provide information regarding smartphone and other digital-device use; and
6. provided written informed consent for participation.

Exclusion Criteria

Participants were excluded if they:

1. had secondary headache attributable to trauma, infection, intracranial pathology, vascular disease, or other identifiable causes;
2. had another predominant primary headache disorder that could interfere with assessment of migraine;
3. had significant ophthalmological disorders associated with headache or visual discomfort;
4. had major neurological or psychiatric disorders that could interfere with reliable history or assessment;
5. were receiving medications known to substantially alter sleep or digital-device usage patterns; or
6. were unwilling or unable to provide informed consent or complete the required assessments.

Data Collection Procedure: After obtaining written informed consent, each participant underwent a detailed clinical evaluation using a structured data collection proforma. Information regarding age, sex, educational or occupational status, relevant medical history, family history of migraine, duration of migraine, medication use, sleep pattern, physical activity, and other potential migraine triggers was recorded.

A detailed headache history was obtained, including age at onset, duration of illness, frequency of migraine attacks, duration of individual attacks, headache location and character, associated symptoms, presence or absence of aura, and use of acute or preventive migraine medications.

Assessment of Smartphone Screen Time: Smartphone screen time was assessed using the participant's built-in digital well-being or screen-time application, wherever available. The average daily screen time during the preceding 7 days was recorded in hours per day. When objective screen-time records were unavailable, average daily smartphone use was obtained through participant self-report. Participants were categorized according to their average daily smartphone screen exposure for analysis. Screen time was also evaluated as a continuous variable in hours per day to assess its relationship with migraine outcomes. Information regarding the pattern of smartphone use, including nighttime use, use immediately before sleep, prolonged uninterrupted use, and predominant purpose of use such as academic/work-related activities, social networking, gaming, entertainment, or communication, was also recorded.

Assessment of Other Digital Device Use: In addition to smartphone exposure, participants were asked about their average daily use of other screen-based digital devices, including laptops, desktop computers, tablets, and televisions. Average daily duration of exposure to each device was recorded separately in hours per day. The total daily digital screen exposure was estimated by combining the reported duration of

smartphone and other digital-device use. Device-specific exposure was also retained separately to determine whether particular types of screen use showed stronger associations with migraine characteristics.

Assessment of Migraine Frequency: Migraine frequency was assessed by recording the number of migraine days and/or attacks per month during the preceding three months. Participants were asked to report their usual monthly frequency, supported by headache diaries or previous records whenever available. Based on monthly migraine frequency, participants were categorized into appropriate frequency groups for comparison. Migraine frequency was additionally analyzed as a continuous outcome to determine its relationship with daily smartphone and total digital screen exposure.

Assessment of Migraine Severity: The severity of migraine headache was assessed using the Visual Analogue Scale (VAS) or an equivalent 0–10 numerical pain-rating scale. Participants rated the usual intensity of their migraine attacks, with higher scores representing greater headache severity. Migraine-related disability was additionally assessed using the Migraine Disability Assessment (MIDAS) questionnaire, where applicable. The total MIDAS score was calculated and participants were classified according to the established disability grades as little or no disability, mild disability, moderate disability, or severe disability.

Assessment of Potential Confounding Factors: Factors potentially associated with both digital-device exposure and migraine were recorded. These included average sleep duration, nighttime smartphone use, physical activity, caffeine consumption, irregular meals, perceived stress, refractive errors or visual symptoms, and other commonly reported migraine triggers. These variables were considered during analysis to evaluate whether the relationship between screen exposure and migraine persisted after accounting for relevant confounding factors.

Study Outcome Measures: The primary outcome measures were the associations of average daily smartphone screen time and total digital-device exposure with migraine frequency and headache severity. Secondary outcome measures included the associations of device-specific screen exposure, nighttime smartphone use, and patterns of digital-device use with migraine duration, migraine-related disability, and other clinical characteristics.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS .21 statistical software package. Continuous variables were expressed as mean $\pm$ standard deviation (SD) for normally distributed data and as median with interquartile range (IQR) for non-normally distributed data. Categorical variables were presented as frequencies and percentages. The normality of continuous variables was assessed using the Shapiro–Wilk test. Differences in continuous variables between two groups were analyzed using the independent-samples Student's *t*-test or Mann–Whitney *U* test, as appropriate. For

comparisons involving more than two screen-time categories, one-way analysis of variance (ANOVA) or the Kruskal–Wallis test was used. Categorical variables were compared using the Chi-square test or Fisher's exact test. The relationship of daily smartphone screen time and total digital-device exposure with migraine frequency, VAS score, and MIDAS score was assessed using Pearson's or Spearman's correlation coefficient, depending on the distribution of the variables. Multivariable regression analysis was performed, where appropriate, to determine whether greater screen exposure was independently associated with migraine frequency or severity after adjustment for relevant confounding variables such as age, sex, sleep duration, stress, and physical activity. A two-tailed *p*-value <0.05 was considered statistically significant.

RESULTS

A total of 90 young adults with migraine were included. The mean age was 24.6 ± 3.5 years, with 41.1% aged 26–30 years, 35.6% aged 22–25 years, and 23.3% aged 18–21 years. Females constituted 62.2% of participants, and 53.3% were students. The median duration of migraine was 3.0 years (IQR: 2.0–5.0). Migraine without aura was present in 68.9%, family history of migraine in 38.9%, and 26.7% were receiving preventive medication [Table 1]. Smartphones were the primary digital device for 84.4% of participants, while 74.4% regularly used laptops/desktops. Smartphone use within one hour before sleep was reported by 80.0%, nighttime smartphone use by 76.7%, and continuous screen exposure for >2 hours without a break by 56.7%. Frequent device use in a dark environment was reported by 47.8%, whereas only 32.2% took regular screen breaks. Digital devices were predominantly used for academic/work activities (38.9%), social media/communication (34.4%), and entertainment/gaming (26.7%) [Table 2 and Figure 1]. The median migraine frequency was 7 days/month (IQR: 4–11); 20.0% experienced <4 migraine days/month, 34.4% experienced 4–7 days, 31.1% experienced 8–14 days, and 14.4% experienced ≥ 15 days/month. Mean headache intensity was 6.7 ± 1.6 on VAS, with 53.3% experiencing severe headache. Median attack duration was 8 hours (IQR: 5–18). The median MIDAS score was 14 (IQR: 7–24), and 31.1% had severe migraine-related disability [Table 3].

Migraine burden increased significantly with increasing smartphone exposure. Median migraine frequency increased from 4 days/month among participants using smartphones for <4 hours/day to 6 days/month with 4–6 hours/day and 9 days/month with >6 hours/day ($p<0.001$). Mean VAS scores similarly increased from 5.5 ± 1.4 to 6.4 ± 1.5 and 7.3 ± 1.4 , respectively ($p<0.001$). Median attack duration increased from 6 to 8 and 12 hours ($p=0.008$), while median MIDAS scores increased from 8 to 12 and 20 ($p<0.001$). Severe headache occurred in 26.7%, 46.7%, and 66.7% of these groups, respectively ($p=0.018$), while severe MIDAS disability occurred in 13.3%, 23.3%, and 42.2% ($p=0.041$) [Table 4]. Smartphone screen time showed significant positive correlations with migraine days/month ($r/\rho=0.52$, $p<0.001$), VAS score ($r/\rho=0.44$, $p<0.001$), MIDAS score ($r/\rho=0.47$, $p<0.001$), and attack duration ($r/\rho=0.31$, $p=0.003$). Total digital screen time was also positively correlated with migraine frequency ($r/\rho=0.48$), VAS score ($r/\rho=0.39$), and MIDAS score ($r/\rho=0.43$), all $p<0.001$.

Nighttime smartphone duration correlated significantly with migraine frequency ($r/p=0.34$, $p=0.001$) (Table 5 and Figure 2). On multivariable analysis, smartphone screen time remained independently associated with greater migraine burden ($\beta=0.41$, 95% CI: 0.19–0.63; $p<0.001$). Significant independent associations were also observed for total digital screen time ($\beta=0.24$, 95% CI: 0.07–0.41; $p=0.006$), nighttime smartphone use ($\beta=0.86$, 95% CI: 0.18–1.54;

$p=0.014$), sleep duration <7 hours/day ($\beta=1.12$, 95% CI: 0.39–1.85; $p=0.003$), and continuous screen use >2 hours ($\beta=0.71$, 95% CI: 0.08–1.34; $p=0.028$). Age and female sex were not independently associated with migraine burden. Overall, greater smartphone and digital screen exposure, particularly prolonged and nighttime use, was significantly associated with increased migraine frequency, severity, attack duration, and disability [Table 6 and Figure 3].

Table 1: Sociodemographic and Baseline Clinical Characteristics of Study Participants (N = 90)

Parameter	Result
Age (years), mean $\pm$ SD	24.6 $\pm$ 3.5
18–21 years	21 (23.3%)
22–25 years	32 (35.6%)
26–30 years	37 (41.1%)
Male	34 (37.8%)
Female	56 (62.2%)
Student	48 (53.3%)
Employed	36 (40.0%)
Others	6 (6.7%)
Duration of migraine (years), median (IQR)	3.0 (2.0–5.0)
Migraine without aura	62 (68.9%)
Migraine with aura	28 (31.1%)
Family history of migraine	35 (38.9%)
Preventive migraine medication use	24 (26.7%)

Table 2: Pattern and Purpose of Smartphone and Digital Device Use Among Study Participants (N = 90)

Parameter	Number (n)	Percentage (%)
Smartphone used as primary digital device	76	84.4
Laptop/desktop regularly used	67	74.4
Television regularly viewed	52	57.8
Tablet regularly used	19	21.1
Smartphone use within 1 hour before sleep	72	80.0
Nighttime smartphone use	69	76.7
Continuous screen use >2 hours without break	51	56.7
Frequent use in a dark environment	43	47.8
Regular screen breaks practiced	29	32.2
Predominantly academic/work-related use	35	38.9
Predominantly social media/communication use	31	34.4
Predominantly entertainment/gaming use	24	26.7

Table 3: Migraine Frequency, Severity, and Disability Among Study Participants (N = 90)

Migraine parameter	Result
Migraine days/month, median (IQR)	7 (4–11)
<4 migraine days/month	18 (20.0%)
4–7 migraine days/month	31 (34.4%)
8–14 migraine days/month	28 (31.1%)
≥ 15 headache days/month	13 (14.4%)
Headache intensity (VAS), mean $\pm$ SD	6.7 $\pm$ 1.6
Mild pain (VAS 1–3)	5 (5.6%)
Moderate pain (VAS 4–6)	37 (41.1%)
Severe pain (VAS 7–10)	48 (53.3%)
Duration of individual attack (hours), median (IQR)	8 (5–18)
MIDAS score, median (IQR)	14 (7–24)
Little/no disability	19 (21.1%)
Mild disability	20 (22.2%)
Moderate disability	23 (25.6%)
Severe disability	28 (31.1%)

Table 4: Comparison of Migraine Characteristics According to Daily Smartphone Screen Time (N = 90)

Migraine parameter	<4 h/day (n=15)	4–6 h/day (n=30)	>6 h/day (n=45)	p-value
Migraine days/month, median (IQR)	4 (3–6)	6 (4–9)	9 (6–13)	<0.001
VAS score, mean $\pm$ SD	5.5 $\pm$ 1.4	6.4 $\pm$ 1.5	7.3 $\pm$ 1.4	<0.001
Attack duration (hours), median (IQR)	6 (4–10)	8 (5–14)	12 (6–24)	0.008
MIDAS score, median (IQR)	8 (4–13)	12 (6–19)	20 (11–29)	<0.001
Severe headache, n (%)	4 (26.7%)	14 (46.7%)	30 (66.7%)	0.018

Severe MIDAS disability, n (%)	2 (13.3%)	7 (23.3%)	19 (42.2%)	0.041
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Table 5: Correlation of Smartphone and Total Digital Screen Time With Migraine Outcomes (N = 90)

Screen exposure	Migraine outcome	Correlation coefficient (r/p)	p-value
Smartphone screen time	Migraine days/month	+0.52	<0.001
Smartphone screen time	VAS score	+0.44	<0.001
Smartphone screen time	MIDAS score	+0.47	<0.001
Smartphone screen time	Attack duration	+0.31	0.003
Total digital screen time	Migraine days/month	+0.48	<0.001
Total digital screen time	VAS score	+0.39	<0.001
Total digital screen time	MIDAS score	+0.43	<0.001
Nighttime smartphone duration	Migraine days/month	+0.34	0.001

Table 6: Multivariable Analysis of Factors Associated With Higher Migraine Frequency and Severity (N = 90)

Predictor	Adjusted effect estimate (β)	95% CI	p-value
Smartphone screen time (per additional hour/day)	+0.41	0.19 to 0.63	<0.001
Total digital screen time (per hour/day)	+0.24	0.07 to 0.41	0.006
Nighttime smartphone use	+0.86	0.18 to 1.54	0.014
Sleep duration <7 hours/day	+1.12	0.39 to 1.85	0.003
Continuous screen use >2 hours	+0.71	0.08 to 1.34	0.028
Age	+0.05	-0.08 to 0.18	0.448
Female sex	+0.38	-0.42 to 1.18	0.348

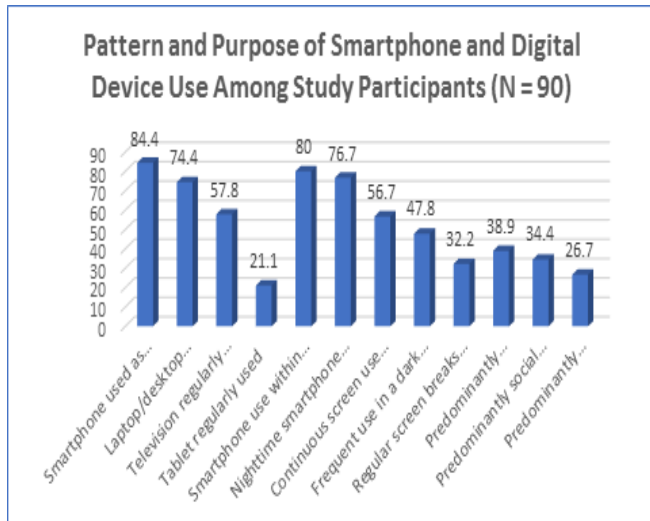


Figure 1: Pattern and Purpose of Smartphone and Digital Device Use Among Study Participants (N = 90)

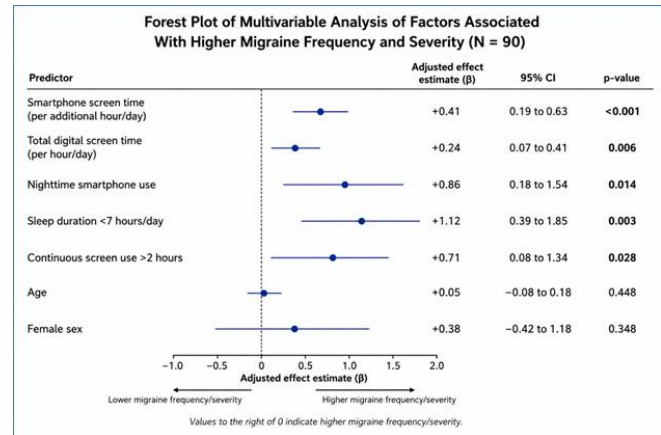


Figure 3: Multivariable Analysis of Factors Associated With Higher Migraine Frequency and Severity (N = 90)

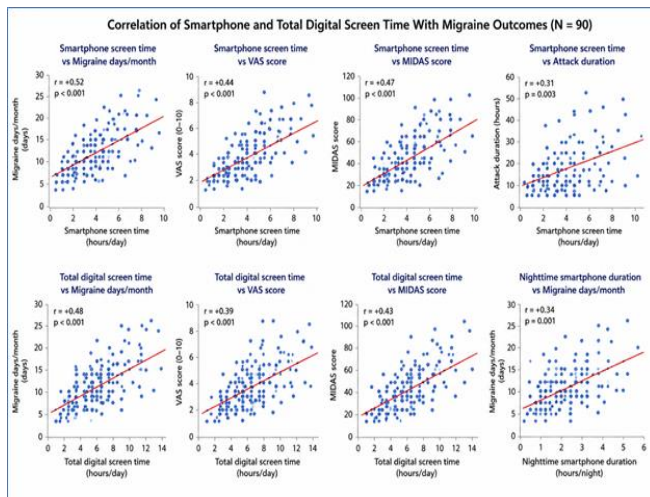


Figure 2: Correlation of Smartphone and Total Digital Screen Time With Migraine Outcomes (N = 90)

DISCUSSION

The present study evaluated the association of smartphone screen time and digital-device use with migraine frequency and severity among 90 young adults. The principal finding was a consistent dose-response relationship between increasing screen exposure and greater migraine burden. Longer smartphone use was associated with more migraine days, greater headache intensity, longer attack duration, and greater migraine-related disability. These associations persisted after adjustment for relevant covariates. The mean age of participants was 24.6 ± 3.5 years, with 41.1% aged 26–30 years. Females constituted 62.2% of the study population, and migraine without aura was more common than migraine with aura (68.9% vs 31.1%). Similar female predominance was reported by Montagni et al,^[14] in 4,927 young adults, of whom 75.5% were female, and by Uttarwar et al,^[15] who reported that women constituted 67% of 400 patients with primary headache. Digital exposure was substantial, with smartphones being the primary device in 84.4% of participants. Nighttime smartphone use was reported by 76.7%, smartphone use within one hour before sleep by

80.0%, and uninterrupted screen exposure for >2 hours by 56.7%. These findings are relevant to the review by Langdon et al,^[16] which included 48 studies and identified duration of screen exposure as the screen-related characteristic most consistently associated with headache. A clear dose-response relationship was observed between smartphone use and migraine frequency. Median migraine days increased from 4 days/month among participants using smartphones for <4 hours/day to 6 days with 4–6 hours/day and 9 days with >6 hours/day ($p<0.001$). Smartphone screen time correlated positively with migraine frequency ($r/\rho=0.52$, $p<0.001$). Montagni et al,^[14] similarly demonstrated progressively increasing migraine risk with greater screen exposure, with very high exposure associated with adjusted odds of migraine of 1.37 (95% CI 1.14–1.66). Headache severity also increased with smartphone exposure. Mean VAS scores increased from 5.5 ± 1.4 in the <4-hour group to 7.3 ± 1.4 in the >6-hour group ($p<0.001$), with a significant positive correlation between screen time and VAS ($r/\rho=0.44$, $p<0.001$). Uttarwar et al,^[15] did not demonstrate comparable differences in headache severity but reported significantly greater analgesic use among smartphone users (95.6% vs 80.9%, $p<0.001$) and higher acute medication consumption among high smartphone users (10 vs 5 pills, $p=0.007$), supporting greater headache burden with heavier smartphone use.

Migraine attack duration also increased from a median of 6 hours with <4 hours/day of smartphone use to 12 hours with >6 hours/day ($p=0.008$), and correlated positively with screen time ($r/\rho=0.31$, $p=0.003$). Evidence regarding attack duration remains limited, as highlighted by Langdon et al,^[16] making this finding clinically relevant.

Migraine-related disability showed a similar pattern. Median MIDAS scores increased from 8 to 20 across the lowest and highest smartphone-use categories ($p<0.001$), while smartphone screen time correlated significantly with MIDAS score ($r/\rho=0.47$, $p<0.001$). Total digital screen time was also correlated with migraine frequency ($r/\rho=0.48$), VAS ($r/\rho=0.39$), and MIDAS ($r/\rho=0.43$), all statistically significant. These findings extend the evidence summarized by Langdon et al,^[16] who noted insufficient previous data regarding screen use and headache-related disability.

On multivariable analysis, each additional hour/day of smartphone use remained independently associated with greater migraine burden ($\beta=0.41$, 95% CI 0.19–0.63; $p<0.001$). Total digital screen time ($\beta=0.24$, $p=0.006$), nighttime smartphone use ($\beta=0.86$, $p=0.014$), sleep duration <7 hours/day ($\beta=1.12$, $p=0.003$), and uninterrupted screen use >2 hours ($\beta=0.71$, $p=0.028$) were also independently significant. These findings are consistent with Montagni et al,^[14] who demonstrated persistence of the screen exposure–migraine association after adjustment for potential confounders.

CONCLUSION

The present study demonstrated a significant association between greater smartphone and total digital screen exposure and increased migraine burden among young

adults. Longer screen time was associated with more frequent migraine days, greater headache severity, longer attack duration, and higher migraine-related disability. Nighttime smartphone use, inadequate sleep, and prolonged uninterrupted screen exposure were also independently associated with worse migraine outcomes. These findings suggest that excessive digital-device use may represent an important modifiable lifestyle factor in migraine management. Reducing unnecessary screen exposure and promoting healthier screen-use and sleep practices may help lessen migraine frequency and severity.

Limitations: The study had certain limitations. The relatively small sample size. The cross-sectional nature of the study prevented establishment of a causal relationship between digital screen exposure and migraine burden. Some screen-use and lifestyle information relied on self-reporting, which may have introduced recall bias. Residual confounding from factors such as stress, sleep quality, physical activity, and caffeine consumption could not be completely excluded.

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