

Association between Smartphone Use and Headache Frequency among Adolescents

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Abstract

Background: Increasing smartphone use among adolescents has raised concerns regarding its potential adverse effects, including headache and sleep disturbances. This study evaluated the association between smartphone-use patterns and headache frequency among adolescents.

Methods: This analytical cross-sectional study included 350 adolescents aged 10–19 years. Smartphone-use duration and patterns, sleep, physical activity, and headache characteristics during the preceding three months were assessed using a structured questionnaire. Associations were evaluated using appropriate statistical tests and multivariable logistic regression.

Results: Recurrent headache was reported by 158 (45.1%) adolescents. Headache prevalence increased progressively from 27.0% with <2 hours/day of smartphone use to 66.7% with >6 hours/day ($p < 0.001$). Smartphone-use duration correlated positively with headache frequency ($r = 0.36$, $p < 0.001$) and intensity ($r = 0.25$, $p = 0.002$). Compared with <2 hours/day, smartphone use for 4–6 hours/day (aOR 2.38; 95% CI 1.17–4.84) and >6 hours/day (aOR 3.76; 95% CI 1.67–8.47) independently predicted recurrent headache. Nighttime smartphone use, continuous use >2 hours, and sleep <7 hours were also significant predictors.

Conclusion: Greater smartphone exposure was associated with a dose-dependent increase in headache prevalence and frequency among adolescents. Reducing prolonged and nighttime smartphone use and promoting adequate sleep may represent practical measures for reducing headache burden.

Keywords: Adolescents; Smartphone Use; Headache; Screen Time; Sleep; Problematic Smartphone Use; Digital Media.

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Introduction

Headache is one of the most frequent neurological complaints among adolescents and may adversely affect school attendance, academic performance, sleep, and quality of life. With the widespread adoption of smartphones and other digital devices, prolonged screen exposure has emerged as a potentially modifiable factor associated with headache among young people. Digital media use may influence migraine and other headache disorders through prolonged visual exposure, altered posture, reduced physical activity, and disruption of sleep patterns [1].

Longitudinal evidence suggests a possible relationship between digital media exposure and headache symptoms during adolescence, although the magnitude and direction of this association may

vary according to the type and duration of media use [2]. A recent scoping review similarly highlighted increasing evidence linking excessive screen exposure with pediatric headache, while emphasizing the need for better characterization of screen duration, device type, and headache outcomes [3]. Smartphone use, particularly around bedtime, may also interfere with sleep duration and quality, which can further contribute to headache susceptibility [4].

Primary headache disorders are already common among children and adolescents worldwide [5]. Smartphone-related sleep disturbances are particularly relevant in this age group because excessive and nighttime smartphone use has been consistently associated with impaired sleep [6].

Problematic smartphone use has additionally been associated with functional somatic symptoms among adolescents, suggesting that its effects may extend beyond sleep and behavioural outcomes [7].

Therefore, the present study aimed to determine the association between smartphone use and headache frequency among adolescents and to identify patterns of smartphone exposure associated with increased headache burden.

Materials and Methods

Study Design and Setting: The present study was designed as a single-centre, analytical cross-sectional study among adolescents attending a tertiary-care teaching institution. The study was conducted over a predefined study period after obtaining the required institutional permissions.

Study Population: Adolescents aged 10–19 years who fulfilled the eligibility criteria were consecutively screened for participation. Participants were evaluated for their pattern and duration of smartphone use and the occurrence and frequency of headaches.

Sample Size: The sample size was calculated using the formula for estimation of a single proportion:

$$n = \frac{Z^2 pq}{d^2}$$

where $Z = 1.96$ at a 95% confidence level, $p =$ anticipated prevalence of headache among adolescents (28%), $q = 1 - p = 72\%$, and $d = 5\%$ absolute precision.

$$n = \frac{(1.96)^2(0.28)(0.72)}{(0.05)^2} \approx 310$$

After allowing approximately 10% for incomplete responses/non-response, the required sample was approximately 341. Therefore, a final sample size of 350 adolescents was planned.

Inclusion Criteria: Adolescents aged 10–19 years who had been using a smartphone regularly for at least the preceding six months, were able to understand and complete the study questionnaire, and provided assent/consent as applicable were included.

Exclusion Criteria: Participants with a known intracranial neurological disorder, recent head injury, acute febrile illness at the time of assessment, significant uncorrected visual impairment, or other diagnosed medical conditions likely to cause secondary headache were excluded.

Adolescents unable to provide reliable information regarding smartphone use were also excluded.

Data Collection

Data were collected using a pre-designed structured questionnaire. Information regarding age, sex, educational status, physical activity, sleep duration, spectacle use, caffeine consumption, and other potentially relevant factors was recorded.

Smartphone-related variables included age at initiation of smartphone use, average daily duration of use, years of use, predominant purpose of use, continuous duration per session, bedtime/nighttime use, and use immediately before sleep.

For analysis, average daily smartphone exposure was categorized as:

- <2 hours/day
- 2–4 hours/day
- 4–6 hours/day
- >6 hours/day

Problematic smartphone use was additionally assessed using the Smartphone Addiction Scale–Short Version (SAS-SV) where applicable.

Assessment of Headache: Participants were asked about the presence of recurrent headache during the preceding three months. Those reporting headache were evaluated for frequency, duration, intensity, associated symptoms, analgesic use, and interference with routine or school activities.

Headache frequency was categorized as no headache, 1–3 days/month, 4–7 days/month, 8–14 days/month, and ≥ 15 days/month. Headache intensity was recorded using a 0–10 numerical rating scale, with higher scores representing greater pain intensity.

The primary outcome was headache frequency according to average daily smartphone-use duration. Secondary outcomes included associations of headache with nighttime smartphone use, continuous screen exposure, problematic smartphone use, sleep duration, and other participant characteristics.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS. Continuous variables were expressed as mean $\pm$ standard deviation or median with interquartile range, as appropriate, while categorical variables were presented as frequencies and percentages.

The association between smartphone-use categories and headache prevalence/frequency was assessed using the Chi-square test or Fisher's exact test. Continuous variables were compared using the independent t-test/ANOVA or corresponding non-parametric tests where appropriate. Spearman or Pearson correlation was used to assess the relationship between daily smartphone-use duration and headache frequency/intensity.

A multivariable logistic regression analysis was performed to determine whether higher smartphone

use was independently associated with recurrent headache after adjustment for potential confounders such as age, sex, sleep duration, physical activity, spectacle use, and caffeine consumption. Adjusted odds ratios (aOR) with 95% confidence intervals were reported. A p-value <0.05 was considered statistically significant.

Results

A total of 350 adolescents were included in the analysis.

The mean age of participants was 15.1 ± 2.2 years, and 184 (52.6%) were males. Overall, 158 (45.1%) adolescents reported recurrent headache during the preceding three months.

Increasing daily smartphone exposure was associated with a progressive increase in both headache prevalence and headache frequency. Adolescents using smartphones for >6 hours/day had the highest headache prevalence and greater headache burden.

Table 1: Baseline characteristics of the study participants (N=350)

Characteristic	Total (N=350)
Age, years, mean $\pm$ SD	15.1 $\pm$ 2.2
Age group, n (%)	
10–13 years	92 (26.3)
14–16 years	151 (43.1)
17–19 years	107 (30.6)
Sex, n (%)	
Male	184 (52.6)
Female	166 (47.4)
Smartphone use, hours/day, mean $\pm$ SD	4.1 $\pm$ 2.0
Daily smartphone use, n (%)	
<2 hours/day	63 (18.0)
2–4 hours/day	126 (36.0)
4–6 hours/day	101 (28.9)
>6 hours/day	60 (17.1)
Nighttime smartphone use	213 (60.9)
Smartphone use within 1 hour before sleep	231 (66.0)
Continuous use >2 hours/session	127 (36.3)
Sleep duration <7 hours/night	121 (34.6)
Low physical activity	116 (33.1)
Recurrent headache during previous 3 months	158 (45.1)

Approximately 46.0% of participants reported smartphone exposure of ≥ 4 hours/day. Nighttime use and smartphone use within one hour before sleep were also common, being reported by 60.9% and 66.0% of adolescents, respectively.

Table 2: Association between daily smartphone use and presence of recurrent headache

Smartphone use	Total	Headache present, n (%)	No headache, n (%)	p-value
<2 hours/day	63	17 (27.0)	46 (73.0)	
2–4 hours/day	126	48 (38.1)	78 (61.9)	
4–6 hours/day	101	53 (52.5)	48 (47.5)	
>6 hours/day	60	40 (66.7)	20 (33.3)	
Total	350	158 (45.1)	192 (54.9)	<0.001

There was a significant dose-response relationship between daily smartphone exposure and headache prevalence ($p < 0.001$). Headache was reported by only 27.0% of adolescents using smartphones for <2 hours/day compared with 66.7% among those using smartphones for >6 hours/day. The

prevalence ratio for headache among adolescents with >6 hours/day of smartphone exposure compared with those using smartphones for <2 hours/day was approximately 2.47, indicating a substantially greater headache burden with prolonged smartphone use.

Table 3: Smartphone use according to headache frequency among adolescents (N=350)

Smartphone use	No headache	1–3 days/month	4–7 days/month	8–14 days/month	≥15 days/month
<2 h/day (n=63)	46 (73.0)	11 (17.5)	4 (6.3)	2 (3.2)	0
2–4 h/day (n=126)	78 (61.9)	29 (23.0)	12 (9.5)	6 (4.8)	1 (0.8)
4–6 h/day (n=101)	48 (47.5)	26 (25.7)	15 (14.9)	9 (8.9)	3 (3.0)
>6 h/day (n=60)	20 (33.3)	14 (23.3)	12 (20.0)	9 (15.0)	5 (8.3)
Total	192 (54.9)	80 (22.9)	43 (12.3)	26 (7.4)	9 (2.6)

A clear shift toward more frequent headaches was observed with increasing smartphone exposure. Headache occurring on ≥ 8 days/month was present in only 3.2% of adolescents using smartphones for <2 hours/day, compared with 23.3% among those with >6 hours/day of use.

The ordinal association between increasing smartphone exposure and increasing headache

frequency was statistically significant ($p < 0.001$). Among the 158 participants reporting headaches, the mean headache intensity was 5.2 ± 1.8 on the 0–10 numerical rating scale.

Daily smartphone-use duration showed a positive correlation with headache frequency (Spearman $r = 0.36$, $p < 0.001$) and headache intensity ($r = 0.25$, $p = 0.002$).

Table 4: Factors associated with recurrent headache and multivariable logistic regression

Variable	Headache n/N (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-value*
Smartphone use				
<2 h/day	17/63 (27.0)	Reference	Reference	—
2–4 h/day	48/126 (38.1)	1.67 (0.86–3.25)	1.48 (0.74–2.96)	0.268
4–6 h/day	53/101 (52.5)	2.99 (1.52–5.88)	2.38 (1.17–4.84)	0.017
>6 h/day	40/60 (66.7)	5.41 (2.52–11.60)	3.76 (1.67–8.47)	0.001
Nighttime smartphone use	115/213 (54.0)	2.50 (1.59–3.92)	1.78 (1.08–2.94)	0.024
Continuous use >2 h/session	76/127 (59.8)	2.57 (1.65–4.01)	1.72 (1.05–2.81)	0.031
Sleep <7 h/night	72/121 (59.5)	2.45 (1.57–3.82)	1.89 (1.15–3.11)	0.012
Low physical activity	62/116 (53.4)	1.65 (1.06–2.57)	1.38 (0.84–2.27)	0.201

*p-values correspond to the adjusted model.

After adjustment for potential confounding variables, prolonged smartphone exposure remained independently associated with recurrent headache. Compared with adolescents using smartphones for <2 hours/day, those using smartphones for 4–6 hours/day had approximately 2.4-fold higher odds of headache (aOR 2.38; 95% CI 1.17–4.84), while those using smartphones for >6 hours/day had nearly four-fold higher odds (aOR 3.76; 95% CI 1.67–8.47).

Nighttime smartphone use, continuous use exceeding two hours per session, and sleep duration below seven hours were also independently associated with headache. Overall, the findings demonstrate a dose-dependent association between increasing smartphone exposure and both the occurrence and frequency of headache among adolescents, even after adjustment for important behavioural factors.

Discussion

The present study demonstrated a significant association between increasing smartphone use and headache among adolescents. Overall, 45.1% of participants reported recurrent headache, with prevalence increasing progressively from 27.0%

among adolescents using smartphones for <2 hours/day to 66.7% among those using them for >6 hours/day. This finding is consistent with Lund et al., who reported an association between screen exposure and headache among children and adolescents, suggesting that prolonged screen use may contribute to greater headache burden [8]. A dose-response pattern was also observed for headache frequency. Adolescents with greater smartphone exposure were more likely to experience headaches on multiple days per month, and smartphone-use duration correlated positively with both headache frequency and intensity. Electronic screen exposure has previously been implicated in childhood headache through mechanisms including visual strain, prolonged near-work, inappropriate posture, reduced physical activity, and disruption of normal sleep patterns [9]. These findings emphasize that the duration and pattern of smartphone use may be as relevant as smartphone use itself.

Problematic smartphone behaviour may additionally contribute to physical and psychological symptoms. The Smartphone Addiction Scale-Short Version provides a useful method for identifying problematic smartphone use

among adolescents [10]. Sleep represents another important pathway linking smartphone exposure with headache. Previous evidence has shown a relationship between problematic smartphone use and impaired sleep [11], which is relevant to the present finding that sleep duration <7 hours/night independently increased the odds of recurrent headache (aOR 1.89). The observed association is also supported by a systematic review and meta-analysis showing that mobile phone use was associated with an increased risk of headache [12]. Similarly, Cerutti et al. demonstrated an association of internet and mobile phone use with headache and other somatic symptoms among adolescents [13]. Portable screen-device access, particularly around bedtime, has also been associated with inadequate sleep duration and poorer sleep outcomes [14]. Thus, the significant associations observed for nighttime smartphone use (aOR 1.78) and prolonged continuous use (aOR 1.72) may partly reflect the combined effects of excessive screen exposure and sleep disruption.

After multivariable adjustment, adolescents using smartphones for 4–6 hours/day had 2.38-fold higher odds, while those using smartphones for >6 hours/day had 3.76-fold higher odds of recurrent headache, compared with those using them for <2 hours/day.

These findings suggest a graded relationship between exposure and headache. However, because the present study was cross-sectional, causality cannot be established; adolescents with frequent headaches may also spend more time using smartphones. Furthermore, self-reported smartphone duration may be subject to recall bias. Nevertheless, standardized assessment of problematic smartphone use, such as the SAS-SV developed for adolescents [15], together with objective screen-time data, could strengthen future longitudinal studies.

Conclusion

Prolonged smartphone use was significantly associated with increased prevalence and frequency of headache among adolescents, with the greatest burden observed among those using smartphones for >6 hours/day. Nighttime use, prolonged continuous sessions, and inadequate sleep were additional factors associated with headache. Promoting balanced smartphone use, regular screen breaks, adequate sleep, and reduced bedtime screen exposure may help reduce headache burden among adolescents.

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