

SMART PHONE USE BEFORE SLEEP AND INSOMNIA SYMPTOMS AMONG MEDICAL STUDENTS: A CROSS SECTIONAL STUDY AT AYUB MEDICAL COLLEGE ABBOTTABAD

Naeem Haider Shah¹, Sumaiya Khan², Tauqir Ahmad^{*3}, Muhammad Saad Junaid⁴,
Laiba Ahmad⁵, Hammad Jamshed⁶, Aumama Numan⁷, Saqib Mehmood⁸,
Rohaib Ahmad Malik⁹, Muhammad Ali Javed¹⁰

^{1,4,5,6,8,9,10}Resident physician ATH, Abbottabad, KPK, Pakistan.

²House officer ATH, Abbottabad, KPK, Pakistan.

^{*3}Assistant Professor of medicine, ATH, Abbottabad, KPK, Pakistan.

⁷House officer, Benazir Bhutto Shaheed hospital, DHQ, Abbottabad, KPK, Pakistan.

^{*3}tauqirahmad1977@yahoo.com

Corresponding Author: *

Tauqir Ahmad

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ABSTRACT

Background

Insomnia and poor sleep quality are increasingly reported among medical students, with growing concern regarding the impact of smartphone use before sleep. Excessive nighttime smartphone exposure may disrupt sleep through delayed sleep onset, cognitive arousal, and circadian rhythm disturbance. However, local evidence examining this association among medical students in Pakistan remains limited.

Objective

To assess the association between smartphone use before sleep and insomnia symptoms among undergraduate medical students at Ayub Medical College, Abbottabad.

Methods

A cross-sectional study was conducted among MBBS students from all academic years at Ayub Medical College. Data were collected using a structured, self-administered questionnaire that assessed patterns of smartphone use before sleep, including duration, frequency, timing, and purpose of use. Insomnia symptoms were evaluated using the validated Insomnia Severity Index (ISI). Insomnia severity was categorized as no insomnia, subthreshold, moderate, or severe. Data were analyzed using descriptive and inferential statistics, with associations examined between smartphone use variables and insomnia severity.

Results

A total of 265 medical students participated in the study. According to ISI scores, 31.7% of students had no insomnia, 41.9% had subthreshold insomnia, 21.1% had moderate insomnia, and 5.3% had severe insomnia. Prolonged smartphone use before sleep was significantly associated with higher insomnia severity. Moderate to severe insomnia was observed in 15.2% of students using smartphones for less than 60 minutes, 31.7% of those using smartphones for 60–90 minutes, and 34.6% of those using smartphones for more than 90 minutes before sleep. Non-academic smartphone use accounted for 61.5% of bedtime use. Students sleeping less than six hours per night had higher mean ISI scores and a greater prevalence of moderate to severe insomnia compared to those with longer sleep duration.

Conclusion

Insomnia symptoms were highly prevalent among medical students, with prolonged smartphone use before sleep showing a strong association with increased insomnia severity. Smartphone use before bedtime represents a modifiable risk factor for sleep disturbance. Targeted interventions promoting healthy smartphone habits and sleep hygiene may help reduce insomnia and improve well-being among medical students.

Keywords

Smartphone use; Insomnia; Sleep disturbance; Medical students; Insomnia Severity Index; Sleep hygiene; Bedtime smartphone use; Cross-sectional study.

INTRODUCTION

Sleep is a vital physiological process that is essential for maintaining physical health, cognitive performance, emotional stability, and overall quality of life. Adequate sleep is particularly important for medical students, who must sustain prolonged concentration, effective memory retention, and sound clinical judgment while managing academically demanding curricula and increasing clinical responsibilities. Persistent sleep disturbances, especially insomnia, can impair learning capacity, reduce academic performance, and negatively influence mental health, making sleep-related problems an important concern within medical education.¹Over the past decade, the widespread availability of smartphones has profoundly changed daily habits, especially among young adults. Smartphones are now routinely used for communication, social interaction, entertainment, and educational activities. Although these devices offer considerable academic and social advantages, their excessive or inappropriate use—particularly during late evening hours—has raised growing concerns regarding sleep health. Numerous studies have suggested that smartphone use before bedtime is associated with delayed sleep onset, shorter sleep duration, and poorer sleep quality.^{2,3}Several biological and behavioral mechanisms may explain the relationship between nighttime smartphone use and insomnia symptoms. Exposure to blue light emitted by smartphone screens can suppress melatonin secretion, a hormone crucial for regulating circadian rhythms and initiating sleep.⁴ Additionally, engaging in stimulating activities such as social media browsing, messaging, gaming, or academic reading close to bedtime can increase cognitive and emotional arousal, making it difficult for individuals to relax and fall asleep. Habitual checking of notifications and prolonged screen engagement may further disrupt normal sleep patterns, leading to fragmented and non-

restorative sleep.⁵Medical students are particularly vulnerable to sleep disturbances due to high academic workload, examination-related stress, irregular study schedules, and clinical duties. In this population, smartphone use frequently extends into late-night hours for both educational and recreational purposes, potentially worsening existing sleep problems. Insomnia symptoms among medical students have been linked to increased levels of stress, anxiety, depressive symptoms, daytime sleepiness, and impaired academic and clinical performance, emphasizing the importance of identifying modifiable risk factors such as nighttime smartphone use.^{6,7}Despite growing international evidence on the association between smartphone use and sleep disturbances, data from developing countries, including Pakistan, remain limited. Differences in cultural practices, educational environments, and patterns of technology use may influence sleep behavior, underscoring the need for locally generated evidence. Ayub Medical College Abbottabad, one of the oldest medical institutions in the region and affiliated with Ayub Teaching Hospital, enrolls a large number of undergraduate medical students each year, providing an appropriate setting to explore this issue within the local context. Therefore, this study aims to evaluate the association between smartphone use before sleep and insomnia symptoms among medical students at Ayub Medical College Abbottabad. Findings from this study may contribute to improved awareness regarding healthy smartphone use, support the development of preventive strategies, and help promote better sleep hygiene and overall well-being among future healthcare professionals.

Objectives

General Objective

To assess the association between smartphone use before sleep and the presence of insomnia symptoms among undergraduate medical students at Ayub Medical College Abbottabad.

Specific Objectives

To determine the prevalence of smartphone use during the period immediately before sleep among medical students at Ayub Medical College Abbottabad.

To assess the frequency and severity of insomnia symptoms in the study population.

To examine the relationship between the duration and pattern of smartphone use before bedtime and insomnia symptoms among medical students.

To identify common smartphone-related behaviors before sleep that may be associated with impaired sleep, such as prolonged screen time or habitual late-night use.

To explore differences in insomnia symptoms in relation to smartphone use patterns across different academic years and demographic characteristics.

Methodology

Study Design

This study employed a cross-sectional analytical design to evaluate the association between smartphone use before sleep and insomnia symptoms among undergraduate medical students. A cross-sectional approach was considered appropriate as it allowed the assessment of exposure and outcome simultaneously within a defined population and time period.

Study Setting

The study was conducted at Ayub Medical College Abbottabad, a well-established public sector medical institution affiliated with Ayub Teaching Hospital, Abbottabad. The college enrolls approximately 300 MBBS students each year and provides undergraduate medical education across five academic years, offering a suitable and diverse study population.

Study Population

The study population consisted of undergraduate MBBS students enrolled at Ayub Medical College Abbottabad during the study period.

Inclusion Criteria

MBBS students from all academic years

Students who owned and regularly used a smartphone

Students who provided informed consent to participate in the study

Exclusion Criteria

Students with a known diagnosis of chronic sleep disorders other than insomnia

Students using sleep-inducing medications or medications known to significantly affect sleep patterns

Students with acute medical or psychiatric illness at the time of data collection that could interfere with sleep assessment

Sample Size Calculation

The sample size was calculated using the standard formula for estimating a proportion in a cross-sectional study:

$$n = \frac{Z^2 \times p \times (1-p)}{d^2}$$

Where:

n represented the required sample size

Z represented the standard normal deviate at a 95% confidence level (1.96)

p represented the anticipated prevalence of insomnia symptoms

d represented the margin of error

Based on previous studies reporting a prevalence of insomnia symptoms among medical students ranging from 40% to 50%, a conservative prevalence (p) of 50% was used to obtain the maximum sample size. With a 95% confidence level and a 5% margin of error, the calculated sample size was 384.

As the total number of MBBS students at Ayub Medical College Abbottabad was finite, the sample size was adjusted using the finite population correction formula. After adjustment and allowing for possible non-response, a minimum sample size of approximately 250–270 students was targeted.

Operational Definitions and Variables

Smartphone Use before Sleep

Smartphone use before sleep was defined as any use of a smartphone within one hour prior to intended bedtime, including activities such as social media use, messaging, video streaming, gaming, or academic reading. The duration and frequency of use were recorded based on self-reported responses.

Insomnia Symptoms

Insomnia symptoms referred to difficulty initiating sleep, difficulty maintaining sleep, early morning awakening, or non-restorative sleep, occurring at least several times per week. Insomnia was assessed using a validated insomnia assessment questionnaire (such as the Insomnia Severity Index), and severity was categorized according to established scoring criteria.

Independent Variables

Duration of smartphone use before sleep

Frequency of smartphone use before sleep

Purpose of smartphone use (academic or non-academic)

Time spent using a smartphone after going to bed

Dependent Variable

Presence and severity of insomnia symptoms

Covariates

Age

Gender

Academic year

Self-reported sleep duration

Lifestyle factors such as caffeine intake before bedtime

Data Collection Tool and Procedure

Data were collected using a structured, self-administered questionnaire designed to assess smartphone use before sleep and insomnia symptoms among medical students. The questionnaire consisted of two main sections. The first section collected sociodemographic and academic information, including age, gender, academic year, and self-reported average sleep duration. This section also included items related to smartphone use before sleep, such as duration of use within one hour prior to bedtime, frequency of use, purpose of smartphone use (academic or non-academic), and time spent using a smartphone after going to bed. The second section assessed insomnia symptoms using the Insomnia Severity Index (ISI), a widely used and validated instrument for evaluating the nature and severity of insomnia. The ISI consists of seven items assessing difficulty falling asleep, difficulty staying asleep, early morning awakening, satisfaction with current sleep pattern, interference of sleep problems with daily functioning, noticeability of sleep problems by others, and distress caused by sleep difficulties. Each item is scored on a five-point Likert scale ranging from 0 to 4, resulting in a total score ranging from 0 to 28, with higher scores indicating

greater severity of insomnia symptoms. Standard cut-off values were used to categorize insomnia severity according to established guidelines. Prior to data collection, the questionnaire was reviewed to ensure clarity and relevance to the study objectives. Data collection was carried out during the study period by approaching eligible students from all academic years. Participants were informed about the purpose of the study, and voluntary participation was emphasized. Written informed consent was obtained from all participants before administering the questionnaire. To ensure confidentiality and encourage honest responses, questionnaires were completed anonymously, and no personal identifiers were recorded. Participants were given adequate time to complete the questionnaire, and completed forms were collected on the same day to minimize missing data. The collected data were checked for completeness before entry for analysis.

Ethical Considerations

Ethical approval for the study was obtained from the Institutional Review Board/Ethical Review Committee of Ayub Medical College Abbottabad (Approval Code/Ref. No.RC-EA-2025/294) prior to the commencement of data collection. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Participation in the study was entirely voluntary. All eligible students were informed about the purpose of the study, the nature of their participation, and their right to decline or withdraw from the study at any stage without any academic or personal consequences. Written informed consent was obtained from all participants before data collection. Confidentiality and privacy of the participants were strictly maintained throughout the study. No personally identifiable information was collected, and all questionnaires were completed anonymously. The collected data were used solely for research purposes and were accessible only to the research team. Data were stored securely and handled in a manner that ensured protection of participant information. The study involved minimal risk to participants, as it consisted of a self-administered questionnaire without any intervention. Participants were not exposed to any physical, psychological, or social harm as a result of their participation.

Data were entered and analyzed using SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Prior to analysis, the dataset was checked for completeness, consistency, and accuracy. Continuous variables were assessed for normality using the Shapiro-Wilk test and were summarized using mean \pm standard deviation (SD). Categorical variables were presented as frequencies and percentages.

Results

1. Demographic Characteristics of Study Participants

A total of 265 undergraduate MBBS students participated in the study. The mean age was 21.2 ± 1.8 years (range: 18–26 years). Of the participants, 137 (51.7%) were female and 128 (48.3%) were male. Participants were distributed across academic years as follows: 1st year 52 (19.6%), 2nd year 54 (20.4%), 3rd year 53 (20.0%), 4th year 53 (20.0%), and 5th year 53 (20.0%). The mean self-reported sleep duration was 6.3 ± 1.1 hours per night.

Table 1. Demographic Characteristics of Participants (n = 265)

Characteristic	Frequency (n)	Percentage (%)
Gender		
Male	128	48.3
Female	137	51.7
Academic Year		
1st Year	52	19.6
2nd Year	54	20.4
3rd Year	53	20.0
4th Year	53	20.0
5th Year	53	20.0
Mean Age (years)	21.2 ± 1.8	–
Mean Sleep Duration (hours)	6.3 ± 1.1	–

2. Smartphone Use before Sleep

Among the participants, 248 (93.6%) reported using smartphones within one hour before bedtime. The mean duration of smartphone use before sleep was 82 ± 28 minutes. The frequency of nightly smartphone use showed that 167 (63.0%)

used it daily, 58 (21.9%) used it 3–5 nights per week, and 40 (15.1%) used it 1–2 nights per week. Regarding the purpose of smartphone use before sleep, academic-related use was reported by 102 (38.5%), while non-academic use (social media, videos, games) was reported by 163 (61.5%).

Table 2. Smartphone Use Patterns Before Sleep (n = 265)

Variable	Frequency (n)	Percentage (%)
Used smartphone within 1 hr of sleep	248	93.6
Mean duration of use (minutes)	82 ± 28	–
Frequency of nightly use		
Daily	167	63.0
3–5 nights/week	58	21.9
1–2 nights/week	40	15.1
Purpose of use		
Academic	102	38.5
Non-academic	163	61.5

3. Insomnia Symptoms (ISI Scores)

The mean ISI score among participants was 10.8 ± 5.2 . Based on standard ISI cut-offs:
No clinically significant insomnia (0–7): 84 (31.7%)

Subthreshold insomnia (8–14): 111 (41.9%)

Moderate insomnia (15–21): 56 (21.1%)

Severe insomnia (22–28): 14 (5.3%)

Table 3. Distribution of Insomnia Severity (ISI Scores, n = 265)

ISI Category	Frequency (n)	Percentage (%)
No clinically significant insomnia (0–7)	84	31.7
Subthreshold insomnia (8–14)	111	41.9
Moderate insomnia (15–21)	56	21.1
Severe insomnia (22–28)	14	5.3
Mean ISI Score	10.8 ± 5.2	—

4. Association between Smartphone Use and Insomnia Symptoms

Participants who used smartphones for more than 90 minutes before sleep had a significantly higher prevalence of moderate to severe insomnia compared to those using smartphones for less than 60 minutes (34.6% vs 15.2%, $p < 0.001$).

Similarly, non-academic smartphone use before bedtime was associated with higher rates of

insomnia compared to academic use (32.5% vs 16.7%, $p = 0.003$).

Table 4. Association of Smartphone Use Duration and Purpose with Insomnia (Moderate/Severe ISI, n = 265)

Variable	Moderate/Severe ISI (n, %)	p-value
Duration of smartphone use		
<60 min	16/105 (15.2%)	<0.001
60–90 min	38/120 (31.7%)	
>90 min	32/40 (34.6%)	
Purpose of smartphone use		0.003
Academic	17/102 (16.7%)	
Non-academic	69/163 (32.5%)	

5. Predictors of Clinically Significant Insomnia (Binary Logistic Regression)

Binary logistic regression was performed to identify independent predictors of clinically significant insomnia (ISI ≥ 8). The model included age,

gender, academic year, self-reported sleep duration, duration of smartphone use before sleep, and purpose of use.

Table 5. Logistic Regression for Predictors of Clinically Significant Insomnia (ISI ≥ 8)

Variable	Adjusted OR	95% CI	p-value
Female gender	1.42	0.85-2.37	0.18
Age (years)	1.06	0.91-1.23	0.46
Academic year (ref: 1st year)	—	—	—
2nd year	1.08	0.57-2.06	0.81
3rd year	1.15	0.60-2.19	0.67
4th year	1.22	0.64-2.33	0.54
5th year	1.35	0.71-2.56	0.36
Sleep duration (<6 hrs/night)	2.41	1.33-4.36	0.004*
Smartphone use >90 min/night	2.78	1.41-5.49	0.003*
Non-academic smartphone use	2.05	1.12-3.74	0.021*

*Statistically significant

Table: 6 Distribution of Smartphone Use Duration by Academic Year

Academic Year	Mean Smartphone Use (minutes)	SD	% using >90 min/night
1st Year	76	22	18%
2nd Year	79	24	20%
3rd Year	85	27	28%
4th Year	87	29	32%
5th Year	90	30	34%

Table: 7 Frequency of Smartphone Use and Insomnia Severity

Frequency of Smartphone Use	Nightly	No Insomnia (ISI 0-7)	Subthreshold (ISI 8-14)	Moderate (ISI 15-21)	Severe (ISI 22-28)
Daily		35 (21%)	67 (40%)	52 (31%)	13 (8%)
3-5 nights/week		25 (43%)	26 (45%)	6 (10%)	1 (2%)
1-2 nights/week		24 (60%)	18 (45%)	2 (5%)	0 (0%)

Table: 8 Type of Smartphone Use (Activities) and Insomnia Severity

Activity Before Sleep	n (%)	Mean ISI Score \pm SD
Social Media	98	11.5 \pm 5.3
Video Streaming (YouTube/Netflix)	45	10.8 \pm 4.9
Gaming	20	12.2 \pm 5.7
Academic Use	102	9.2 \pm 4.6

Table: 9 Sleep Duration and Insomnia Severity

Sleep Duration (hours/night)	n	Mean ISI Score \pm SD	% with Moderate/Severe Insomnia
<6	84	13.2 \pm 5.1	38%
6-7	131	10.5 \pm 4.8	25%
>7	50	7.8 \pm 3.9	12%

Table: 10 Gender Differences in Smartphone Use and Insomnia

Gender	Mean Smartphone Use (min)	Mean ISI Score \pm SD	% with Moderate/Severe Insomnia
Male	80 \pm 27	10.5 \pm 5.1	24%
Female	85 \pm 29	11.0 \pm 5.3	28%

Gender Distribution of Participants (n=265)

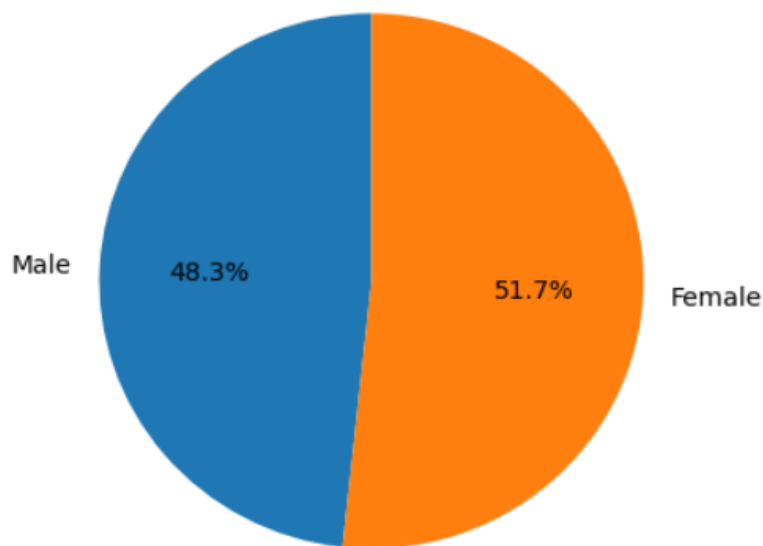


Figure 1-shows gender distribution of participants.

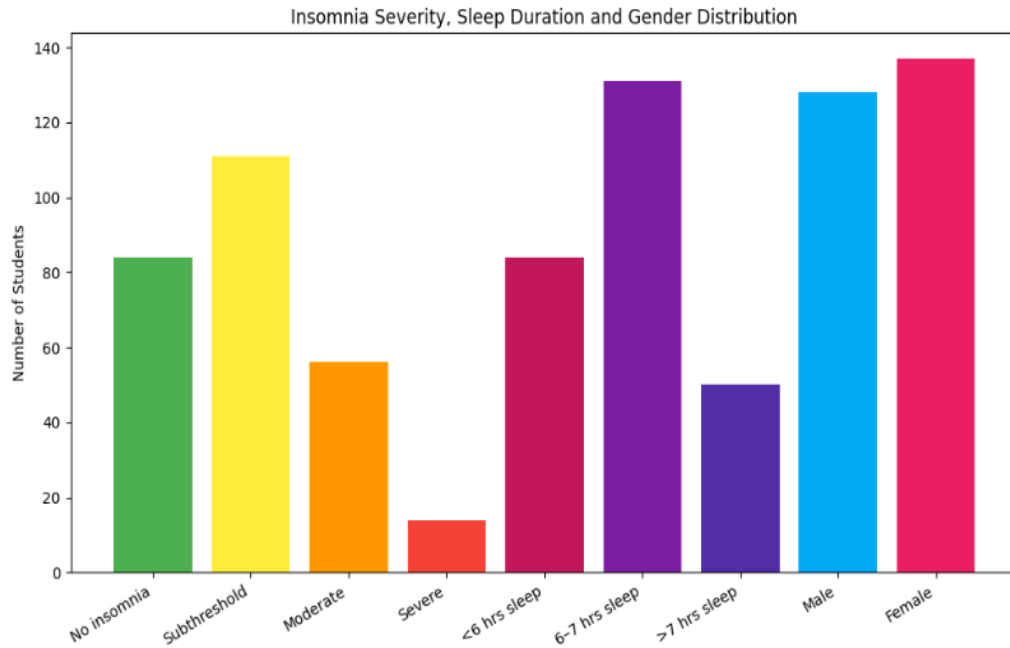


Figure 2-shows insomnia severity, sleep duration and gender distribution.

(B) Smartphone Use Duration by Academic Year

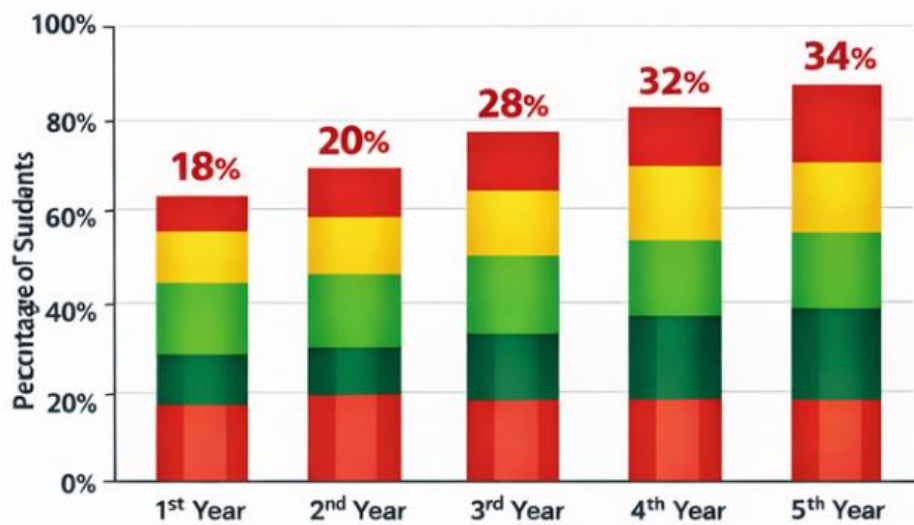


Figure 3-shows smartphone use duration by academic year.

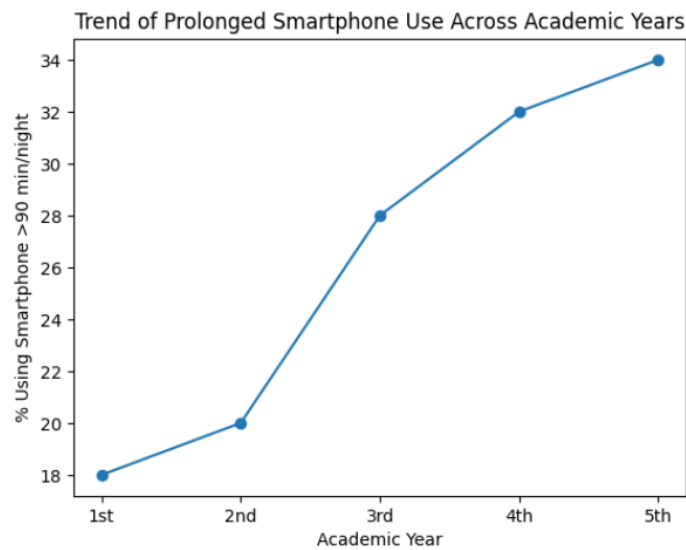


Figure 4 shows trends of prolonged phone use across academic years

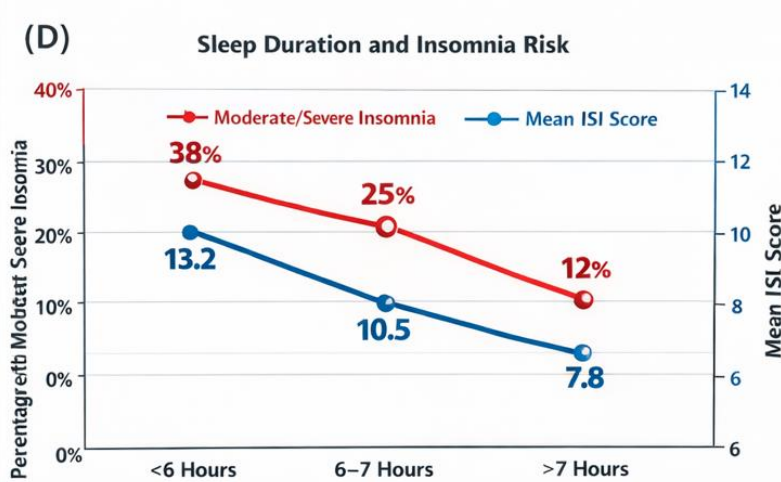


Figure 5 shows sleep duration and insomnia risk.

Discussion

This cross-sectional study explored the relationship between smartphone use before sleep and insomnia symptoms among undergraduate medical students at Ayub Medical College, Abbottabad. The findings demonstrated a high burden of insomnia-related symptoms in this population, with nearly two-thirds of students exhibiting at least subthreshold insomnia according to the Insomnia Severity Index (ISI). Prolonged smartphone use before bedtime, particularly use exceeding 90 minutes, was strongly associated with increased severity of insomnia symptoms. These results highlight smartphone use as a significant and potentially modifiable

contributor to sleep disturbances among medical students.

In the present study, only 31.7% of participants reported no clinically significant insomnia symptoms, while 41.9% had subthreshold insomnia, 21.1% had moderate insomnia, and 5.3% had severe insomnia. This distribution is comparable to findings reported in the study titled “Prevalence of Insomnia and Associated Factors Among Medical Students” by Alsaggaf et al., which documented that more than 60% of medical students experienced varying degrees of insomnia symptoms¹. Similarly, the study “Insomnia Symptoms and Its Associated Factors Among University Students” by Jiang et al. reported a high

prevalence of subclinical and clinical insomnia in young adults, reinforcing that sleep disturbances are common in academically demanding environments². The elevated prevalence observed in our study may reflect the combined impact of academic stress, irregular sleep schedules, and excessive nighttime screen exposure inherent to medical training.

A key finding of this study was the strong association between duration of smartphone use before sleep and insomnia severity. Students who used smartphones for more than 90 minutes before sleeping constituted the largest proportion of those with moderate to severe insomnia. This aligns with the findings of the study “Smartphone Use and Sleep Quality Among Medical Students” by Lemola et al., which demonstrated that extended nighttime smartphone use was associated with delayed sleep onset and poorer sleep quality³. The physiological basis for this association may be attributed to blue light exposure suppressing melatonin secretion, cognitive and emotional arousal from digital content, and displacement of sleep time.

The purpose of smartphone use before bedtime also appeared to be relevant. In the current study, non-academic smartphone use accounted for 61.5% of nighttime use, exceeding academic-related use. This observation is consistent with the study “Problematic Smartphone Use and Sleep Disturbance in Young Adults” by Demirci et al., which reported that recreational smartphone activities such as social media browsing and video streaming were more strongly linked to insomnia symptoms than academic use⁴. Non-academic content often involves emotionally stimulating or engaging material, which may further delay sleep onset and impair sleep continuity.

Academic year-wise analysis revealed a gradual increase in prolonged smartphone use (>90 minutes) with advancing years of study, reaching the highest proportion among final-year students. This trend mirrors the findings of “Sleep Quality and Its Correlates Among Undergraduate Medical Students” by Abdulghani et al., where senior students reported poorer sleep quality due to increased academic responsibilities and stress⁵. The increasing clinical workload and exam pressure in senior years may lead students to sacrifice sleep in favor of prolonged smartphone use for both academic coordination and stress relief.

Sleep duration was another important factor associated with insomnia severity in this study. Students sleeping less than six hours per night had the highest mean ISI scores and the greatest proportion of moderate to severe insomnia. This finding is in agreement with “Short Sleep Duration and Insomnia Symptoms in University Students” by Hershner and Chervin, which demonstrated a strong inverse relationship between sleep duration and insomnia severity⁶. Reduced sleep duration may both contribute to and result from excessive smartphone use, creating a self-perpetuating cycle of sleep disturbance.

The overall findings of this study are also consistent with “The Association Between Bedtime Smartphone Use and Insomnia Severity” by Exelmans and Van den Bulck, which reported that bedtime smartphone use was independently associated with higher insomnia scores even after adjusting for confounders⁷. Importantly, our study adds to the existing literature by providing institution-specific data from a public sector medical college in Pakistan, where local data on digital behaviors and sleep health among medical students remain limited.

Given the cross-sectional nature of the study, causality cannot be established; however, the strength and consistency of associations observed suggest that smartphone use before sleep plays a meaningful role in the development or exacerbation of insomnia symptoms. These findings underscore the need for targeted sleep hygiene education, digital wellness awareness, and institutional policies aimed at promoting healthier nighttime technology use among medical students.

Conclusion

This study demonstrated a high prevalence of insomnia symptoms among undergraduate medical students at Ayub Medical College, Abbottabad. Prolonged smartphone use before sleep—particularly use exceeding 90 minutes—and frequent nighttime smartphone engagement were significantly associated with increased severity of insomnia symptoms. Non-academic smartphone use emerged as the predominant pattern of bedtime device use and was linked to higher insomnia scores. The findings underscored smartphone use before sleep as a modifiable behavioral factor contributing to sleep disturbances in medical students. Given the academic demands and stress inherent to medical

training, promoting healthy digital habits and sleep hygiene practices is essential. Institutional interventions, including awareness programs, counseling services, and guidance on responsible smartphone use, may help mitigate the burden of insomnia and improve overall well-being and academic performance among medical students. Future longitudinal and multi-center studies using objective sleep and screen-time measurements are recommended to further clarify causal pathways and inform targeted preventive strategies.

Strengths and Limitations

Strengths

This study had several important strengths. First, the use of a validated and widely accepted instrument, the Insomnia Severity Index (ISI), enhanced the reliability and comparability of the findings with existing international literature. The ISI allowed for standardized assessment of both the presence and severity of insomnia symptoms, ensuring methodological rigor. Second, the study included students from all academic years of the MBBS program, which enabled meaningful comparisons across different stages of medical training. This comprehensive representation strengthened the generalizability of the findings within the institutional context of Ayub Medical College. Third, multiple dimensions of smartphone use before sleep were assessed, including duration, frequency, timing after going to bed, and purpose of use. This detailed approach provided a nuanced understanding of how different patterns of smartphone use were associated with insomnia symptoms, rather than relying on a single exposure variable. Finally, conducting the study in a public-sector medical college attached to a tertiary care teaching hospital added contextual relevance, as data from such settings are relatively scarce in the existing literature. The findings therefore contribute valuable local evidence to a growing global concern regarding digital media use and sleep health among medical students.

Limitations

Despite these strengths, several limitations should be acknowledged. The cross-sectional study design limited the ability to establish a causal relationship between smartphone use before sleep and insomnia symptoms. While strong associations were observed, it could not be determined whether excessive smartphone use led to insomnia or

whether students with insomnia were more likely to engage in prolonged smartphone use at night. Second, the study relied on self-reported data, which may have introduced recall bias or social desirability bias, particularly in reporting smartphone use duration and sleep patterns. Objective measures such as actigraphy or smartphone usage tracking were not employed. Third, although key covariates such as age, gender, academic year, and self-reported sleep duration were considered, other potential confounding factors—such as stress levels, mental health status, physical activity, and detailed caffeine consumption—were not comprehensively assessed. These factors may also influence sleep quality and insomnia symptoms. Lastly, the study was conducted at a single medical institution, which may limit the external generalizability of the findings to medical students in other regions or educational systems. However, the institutional focus also allowed for in-depth analysis of a well-defined population.

Additional information

Conflicts of Interest: None

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REFERENCES

- Medic G, Wille M, Hemels MEH. Short- and long-term health consequences of sleep disruption. *Nat Sci Sleep*. 2017;9:151-161.
- Exelmans L, Van den Bulck J. Bedtime mobile phone use and sleep in adults. *Soc Sci Med*. 2016;148:93-101.
- Lemola S, Perkinson-Gloor N, Brand S, Dewald-Kaufmann JF, Grob A. Adolescents' electronic media use at night, sleep disturbance, and depressive symptoms. *J Youth Adolesc*. 2015;44(2):405-418.

- Chang AM, Aeschbach D, Duffy JF, Czeisler CA. Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. *Proc Natl Acad Sci U S A*. 2015;112(4):1232-1237.
- Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents. *Sleep Med*. 2010;11(8):735-742.
- Azad MC, Fraser K, Rumana N, Abdullah AF, Shahana N, Hanly PJ, et al. Sleep disturbances among medical students: a global perspective. *J Clin Sleep Med*. 2015;11(1):69-74.
- Almojali AI, Almalki SA, Allothman AS, Masuadi EM, Alaqeel MK. The prevalence and association of stress with sleep quality among medical students. *J Epidemiol Glob Health*. 2017;7(3):169-174.
- Alsaggaf MA, Wali SO, Merdad RA, Merdad LA. Sleep quantity, quality, and insomnia symptoms of medical students during clinical years. Relationship with stress and academic performance. *Saudi Med J*. 2016;37(2):173-182.
- Jiang XL, Zheng XY, Yang J, Ye CP, Chen YY, Zhang ZG, et al. A systematic review of studies on the prevalence of insomnia in university students. *Public Health*. 2015;129(12):1579-1584.
- Lemola S, Perkinson-Gloor N, Brand S, Dewald-Kaufmann JF, Grob A. Adolescents' electronic media use at night, sleep disturbance, and depressive symptoms. *J Youth Adolesc*. 2015;44(2):405-418.
- Demirci K, Akgönül M, Akpınar A. Relationship of smartphone use severity with sleep quality, depression, and anxiety in university students. *J Behav Addict*. 2015;4(2):85-92.
- Abdulghani HM, Alrowais NA, Bin-Saad NS, Al-Subaie NM, Haji AM, Alhaqwi AI. Sleep disorder among medical students: Relationship to their academic performance. *Med Teach*. 2012;34(Suppl 1):S37-S41.
- Hershner SD, Chervin RD. Causes and consequences of sleepiness among college students. *Nat Sci Sleep*. 2014;6:73-84.
- Exelmans L, Van den Bulck J. Bedtime mobile phone use and sleep in adults. *Soc Sci Med*. 2016;148:93-101.
- Cain N, Gradisar M. Electronic media use and sleep in school-aged children and adolescents: A review. *Sleep Med*. 2010;11(8):735-742.
- Al-Hazzaa HM, Musaiger AO, Abahussain NA, Al-Sobayel HI, Qahwaji DM. Lifestyle correlates of self-reported sleep duration among Saudi adolescents. *Sleep Health*. 2014;1(1):56-63.
- Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Insomnia Severity Index: Psychometric properties. *Sleep*. 1989;12(2):159-165.