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Research Article

Screen Use and Sleep Habits among Secondary School Students: A Cross-Sectional Study

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teenager sleep habits, screen time, sleep, smartphone use, school students, sleep quality, sleep deprivation, sleep duration, social media, sleep hygiene

Abstract

Background: Adolescence is a critical period of growth and development during which adequate sleep is essential for cognitive performance, emotional regulation, physical health, and overall well-being. Increasing exposure to smartphones, social media, and evening screen-based activities may further contribute to sleep disruption.

Objective: To assess sleep duration and sleep quality among secondary school students and determine their association with screen exposure, smartphone use, late-night studying, academic workload, physical activity, caffeine consumption, and perceived stress.

Methods: A school-based cross-sectional study was conducted in Karak, Pakistan, among 500 students aged 14–18 years selected from randomly chosen secondary schools using multistage cluster sampling. Data were collected using a structured questionnaire covering demographic characteristics, technology use, academic and lifestyle behaviors, and sleep patterns. Subjective sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), with a PSQI score >5 indicating poor sleep quality. Descriptive statistics, independent-samples t-tests, chi-square tests, correlation analysis, multiple linear regression, and multivariable logistic regression were performed. Adjusted beta coefficients, odds ratios (ORs), 95% confidence intervals (CIs), and p-values were reported, with statistical significance defined as $p<0.05$.

Results: The mean age of participants was 15.8 ± 1.2 years, and females comprised 54.0% of the sample. Mean school-night sleep duration was 6.8 ± 1.1 hours, compared with 8.5 ± 1.2 hours on weekends ($p<0.001$), while only 15.0% of students achieved ≥8 hours of sleep on school nights. Poor sleep quality (PSQI >5) was identified in 35.0% of participants. Technology exposure was substantial, with mean total screen time of 5.1 ± 1.9 hours/day and evening screen exposure after 9:00 pm of 2.5 ± 1.0 hours. Smartphone use within 30 minutes of sleep was reported by 68.8%, while 60.0% used smartphones in bed and 72.2% kept their smartphone beside the bed during sleep. Evening screen time was inversely correlated with sleep duration ($r=-0.42$, $p<0.001$) and positively correlated with PSQI score ($r=0.39$, $p<0.001$). In multivariable linear regression, evening screen time ($\beta=-0.30$, $p<0.001$), smartphone use in bed ($\beta=-0.42$, $p=0.001$), social media use ($\beta=-0.14$, $p=0.006$),

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late-night studying (β=−0.20, p=0.014), high academic workload (β=−0.25, p=0.025), and high perceived stress (β=−0.31, p=0.012) were independently associated with shorter sleep duration. In logistic regression, high perceived stress (AOR=2.42, 95% CI: 1.56–3.76, p<0.001) and evening screen exposure ≥2 hours (AOR=2.31, 95% CI: 1.51–3.53, p<0.001) were the strongest independent predictors of poor sleep quality. Smartphone use in bed, social media use, high academic workload, and evening caffeine consumption were also associated with increased odds of poor sleep quality, whereas regular physical activity was associated with lower odds (AOR=0.64, 95% CI: 0.41–0.99, p=0.046).

Conclusion: Insufficient sleep and poor sleep quality were common among secondary school students, with substantial differences between school-night and weekend sleep duration. Evening screen exposure, bedtime smartphone use, late-night studying, academic workload, and perceived stress emerged as important modifiable factors associated with adverse sleep outcomes. School- and family-based interventions promoting healthy sleep hygiene, limiting evening technology exposure, encouraging regular physical activity, managing academic workload, and addressing psychosocial stress may help improve adolescent sleep health.

Introduction

Adolescence is a sensitive developmental stage marked by rapid physical growth, hormonal changes, and increased academic and social demands. Sufficient sleep—8 to 10 hours per night—is essential for maintaining mental health, learning ability, and overall well-being (CDC, 2024). Unfortunately, many secondary school students do not meet this recommendation, with sleep deprivation becoming increasingly common worldwide (Akçay & Akçay, 2018).

Insufficient or poor-quality sleep can negatively impact cognitive and emotional functioning. Studies have shown that adolescents with inadequate sleep experience memory loss, reduced concentration, mood swings, and impaired problem-solving abilities (Mehta, 2022). Furthermore, sleep quality—including sleep onset, continuity, and consistency—is equally important as sleep duration. Students with regular and high-quality sleep tend to perform better academically and maintain better psychological health (Okano et al., 2019).

Modern lifestyle factors such as extended screen time, late-night smartphone use, and long study hours are among the most common causes of disturbed sleep among adolescents. Exposure to blue light from devices delays melatonin secretion, which disrupts circadian rhythms and makes it harder to fall asleep on time (Chang, A.-M., et al. (2015). In addition, social media browsing and online gaming can increase psychological stimulation, further delaying bedtime and reducing total sleep duration (Brautsch et al., 2023).

School schedules also influence adolescent sleep patterns. Many secondary schools begin early in the morning, forcing students to wake up before completing sufficient rest. This mismatch between biological sleep cycles and school requirements results in chronic sleep deprivation, daytime fatigue, and poor academic performance. Research shows that delaying school start times improves both sleep quality and learning outcomes (American Academy of Pediatrics, 2014; Yip et al. 2022).

Although global studies confirm the relationship between usage habits and poor sleep outcomes, limited evidence is available from developing regions such as South Asia. Factors such as academic stress, cultural expectations, and unregulated technology use may worsen the problem. Therefore, there is a need to examine both sleep habits and usage patterns in secondary school students in these contexts.

The present study aims to assess the sleep duration, quality, and consistency of secondary school students, with a focus on how usage habits—screen time, study load, and smartphone

use—affect their sleep. The findings may provide valuable insights for educators, parents, and policymakers to promote healthier sleep behaviors and improve academic as well as mental health outcomes.

Materials and Methods

Study Design and Setting

A school-based cross-sectional study was conducted among secondary school students aged 14–18 years enrolled in selected secondary schools in Karak, Pakistan. The study was designed to assess sleep duration and sleep quality and to determine their association with evening screen exposure, smartphone use, social media use, late-night studying, physical activity, academic workload, and perceived stress.

Participants

Students aged 14–18 years who were enrolled in Grades 9 and 10, were present during the data-collection period, and provided assent with parental/guardian consent were eligible for participation. Students with a previously diagnosed sleep disorder, chronic medical or psychiatric illness likely to substantially affect sleep, or current use of medications known to influence sleep were excluded.

Sample Size

The minimum sample size was estimated using the single-population proportion formula:

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

Here Z=1.96 for a 95% confidence level, P=0.30 was the anticipated prevalence of poor sleep quality, and d=0.05 was the desired margin of error. The calculated minimum sample size was approximately 323 students. Considering the cluster/multistage sampling design, a design effect and potential non-response were incorporated, resulting in a target sample of 500 students.

Sampling Procedure

A multistage cluster sampling technique was employed. In the first stage, eligible secondary schools were identified and selected using random sampling. In the second stage, classes within the selected schools were randomly selected. In the final stage, all eligible students present in the selected classes were invited to participate. This approach was used to improve representation of students from different schools and residential backgrounds.

Data Collection Instruments

A structured questionnaire was used to collect demographic, behavioral, academic, and sleep-related information. Information was obtained regarding age, sex, grade, residence (urban/rural), family structure, number of siblings, parental education, and perceived household socioeconomic status.

Sleep Assessment

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI). The PSQI evaluates subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. A global PSQI score >5 was considered indicative of poor sleep quality.

Students also reported usual bedtime, wake-up time, sleep duration on school nights, sleep duration on weekends, night-time awakenings, difficulty falling asleep, and daytime sleepiness.
Sleep duration was additionally categorized as <6 hours, 6–<7 hours, 7–<8 hours, and ≥8 hours per night. The proportion meeting the recommended minimum of 8 hours was also calculated.

Screen and Technology Use

Technology-related variables included total daily screen time, evening screen time after 9:00 pm, smartphone use in bed, television use before sleep, social media use, gaming, and whether the smartphone was kept within reach during sleep.
Academic and Lifestyle Variables
Information was collected regarding study hours after 8:00 pm, homework burden, perceived academic workload, physical activity, caffeine/energy-drink consumption, and daytime naps.

Perceived Stress

Perceived stress was assessed using a standardized perceived-stress measure/questionnaire. Scores were categorized into low, moderate, and high perceived stress according to the instrument's recommended cut-offs.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 26. Continuous variables were

summarized as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages.

The independent-samples t-test was used to compare normally distributed continuous variables between two groups, while the Mann–Whitney U test was applied when normality assumptions were not satisfied. Comparisons involving more than two groups were performed using one-way analysis of variance (ANOVA) or the Kruskal–Wallis test, as appropriate. Associations between categorical variables were assessed using the Pearson chi-square test, with Fisher's exact test used when expected cell frequencies were small.

Pearson or Spearman correlation analysis was used to assess relationships between screen exposure, sleep duration, PSQI score, stress, and other continuous variables according to data distribution.

Multiple linear regression was performed to identify independent predictors of sleep duration and PSQI score. Multiple logistic regression was used to identify independent predictors of poor sleep quality (PSQI >5). Variables with clinical relevance and/or $p<0.20$ in univariable analyses were considered for multivariable models. Adjusted beta coefficients (β), adjusted odds ratios (AORs), 95% confidence intervals (CIs), and p-values were reported. Multicollinearity was assessed using the variance inflation factor (VIF). Statistical significance was defined as a two-sided p-value <0.05.

Ethical Considerations

Permission was obtained from the relevant school authorities before data collection. Written informed consent was obtained from parents/guardians and assent was obtained from participating students. Participation was voluntary, confidentiality was maintained, and students were informed that they could withdraw from the study at any time without penalty.

Results

The study included 500 secondary school students with a mean age of 15.8 ± 1.2 years; females constituted a slightly larger proportion than males (54.0% vs. 46.0%). Most participants were from urban areas (65.0%), while Grades 9 and 10 were equally represented (Table 1). A majority reported a nuclear family structure (68.4%), and approximately two-thirds perceived their socioeconomic status as middle (64.2%). Significant differences were observed across residential setting, number of siblings, maternal education, paternal education, and socioeconomic status ($p \leq 0.016$).

Table 1: Demographic and family characteristics of secondary school students

Variable	Category	n (%)	Statistical test	p-value
Sex	Male	230 (46.0)	$\chi^2=3.20$	0.074
	Female	270 (54.0)		
Age	14–15 years	210 (42.0)	$\chi^2=1.80$	0.180
	16–18 years	290 (58.0)		
Grade	9th	250 (50.0)	$\chi^2=0.00$	1.000
	10th	250 (50.0)		
Residence	Urban	325 (65.0)	$\chi^2=45.00$	<0.001
	Rural	175 (35.0)		
Family structure	Nuclear	342 (68.4)	$\chi^2=67.71$	<0.001
	Joint/extended	158 (31.6)		
Siblings	≤2	284 (56.8)	$\chi^2=9.25$	0.002
	≥3	216 (43.2)		
Maternal education	≤Secondary	238 (47.6)	$\chi^2=5.83$	0.016
	≥College	262 (52.4)		
Paternal education	≤Secondary	201 (40.2)	$\chi^2=19.21$	<0.001
	≥College	299 (59.8)		
Perceived socioeconomic status	Low	96 (19.2)	$\chi^2=76.29$	<0.001
	Middle	321 (64.2)		

	High	83 (16.6)		

Note: χ^2 = Pearson chi-square test. P<0.05 was considered statistically significant.

Figure 1 illustrates the demographic distribution of participants. Females represented a modest majority of the sample, while students aged 16–18 years were more common than those aged 14–15 years. Grades 9 and 10 contributed equally to the study population, and urban students substantially outnumbered rural students (65.0% vs. 35.0%).

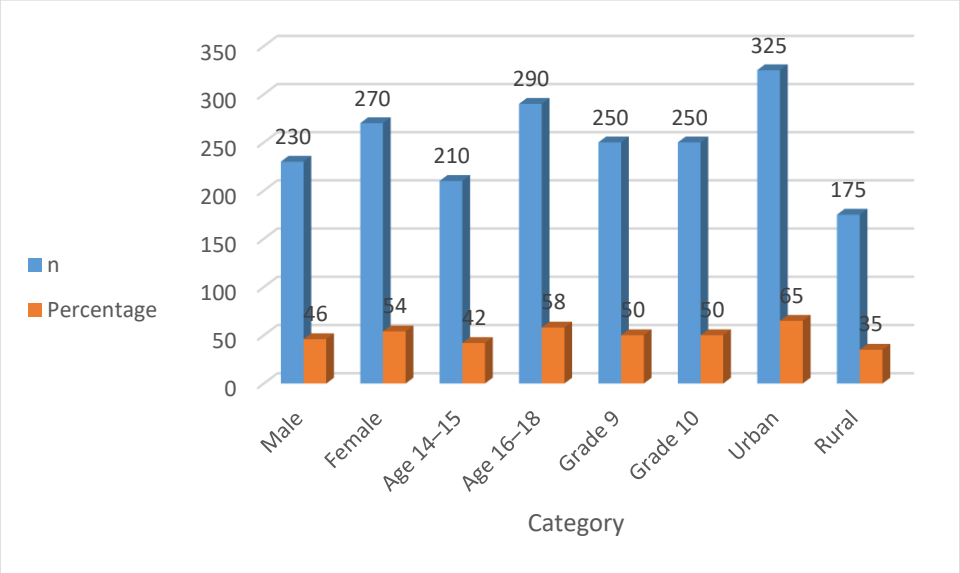

Figure 1: Distribution of secondary school students according to sex, age group, grade level, and residential setting (n=500).

Students reported a mean school-night sleep duration of 6.8 ± 1.1 hours compared with 8.5 ± 1.2 hours on weekends, representing a significant increase in weekend sleep duration (p<0.001). Only 15.0% of participants achieved ≥8 hours of sleep on school nights, whereas 52.0% slept for less than 7 hours. The mean PSQI score was 5.4 ± 2.8, and 35.0% of students were classified as having poor sleep quality (PSQI >5), highlighting a substantial burden of inadequate and poor-quality sleep (Table 2).

Table 2: Sleep patterns among secondary school students

Variable	Mean ± SD / n (%)	Statistical test	p-value
Age (years)	15.8 ± 1.2	—	—
School-night bedtime	23:30 ± 00:45	—	—
School-day wake-up time	06:30 ± 00:30	—	—
School-night sleep duration (hours)	6.8 ± 1.1	Paired t=21.46	<0.001
Weekend sleep duration (hours)	8.5 ± 1.2		
Difference: weekend − school-night sleep	1.7 ± 1.0 h	—	—
Sleep duration			
<6 h	72 (14.4)	χ^2=—	—
6–<7 h	188 (37.6)		
7–<8 h	165 (33.0)		
≥8 h	75 (15.0)		
Difficulty falling asleep			
Never/rarely	285 (57.0)	χ^2=58.31	<0.001
Sometimes	151 (30.2)		
Frequently	64 (12.8)		
Night-time awakening	172 (34.4)	χ^2=48.78	<0.001
Daytime sleepiness	194 (38.8)	χ^2=31.68	<0.001
PSQI score	5.4 ± 2.8	—	—

PSQI ≤5 (good sleep quality)	325 (65.0)	χ^2=45.00	<0.001
PSQI >5 (poor sleep quality)	175 (35.0)		

Figure 2 demonstrates that inadequate sleep was common among the participants. The largest proportion of students (37.6%) reported sleeping 6–<7 hours per school night, followed by 33.0% sleeping 7–<8 hours, while only 15.0% achieved at least 8 hours of sleep. Thus, most students did not reach the recommended sleep duration.

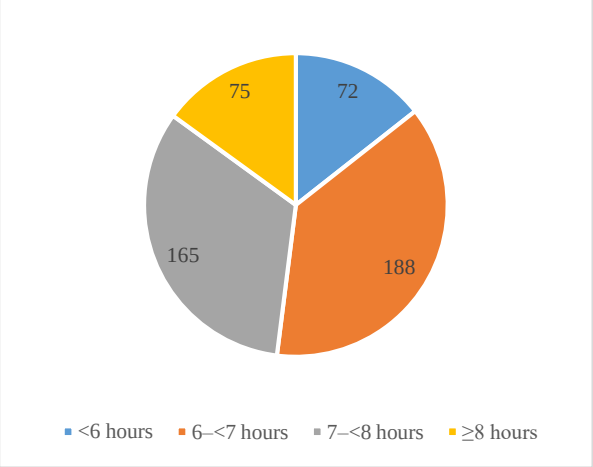

Figure 2: Distribution of participants according to school-night sleep duration categories (n=500).

Technology exposure was high among the participants, with a mean total daily screen time of 5.1 ± 1.9 hours and evening screen exposure after 9:00 pm of 2.5 ± 1.0 hours (Table 3). Smartphone use before or during bedtime was particularly common, with 68.8% using a smartphone within 30 minutes of sleep and 60.0% using it while in bed. In addition, 47.6% reported a high academic workload, 42.8% took daytime naps, and 27.4% consumed caffeinated beverages after 6:00 pm, indicating several potentially modifiable behaviors relevant to sleep health.

Table 3: Technology use, academic workload, and lifestyle characteristics of secondary school students

Variable	Mean ± SD / n (%)
Total daily screen time (hours)	5.1 ± 1.9
Evening screen time after 9 pm (hours)	2.5 ± 1.0
Smartphone use within 30 min before sleep	344 (68.8)
Smartphone use while in bed	300 (60.0)
Smartphone kept beside bed during sleep	361 (72.2)
Social media use (hours/day)	2.0 ± 1.2
Gaming (hours/day)	1.1 ± 0.9
Television/video streaming before bed	219 (43.8)
Study after 8 pm (hours)	1.5 ± 0.7
Homework ≥2 h/night	187 (37.4)
Perceived high academic workload	238 (47.6)
Physical activity ≥60 min/day	156 (31.2)
Daytime nap	214 (42.8)
Caffeinated beverages after 6 pm	137 (27.4)
Energy-drink consumption	82 (16.4)

The students demonstrated substantial exposure to screen-based activities, particularly during the evening (Figure 3). Mean total daily screen time was 5.1 hours, of which 2.5 hours occurred after 9:00 pm. Social media use averaged 2.0 hours/day, while gaming accounted for approximately 1.1 hours/day. Students also reported an average of 1.5 hours of late-night studying, indicating that both recreational screen exposure and academic activities may contribute to delayed bedtimes and reduced sleep opportunity.

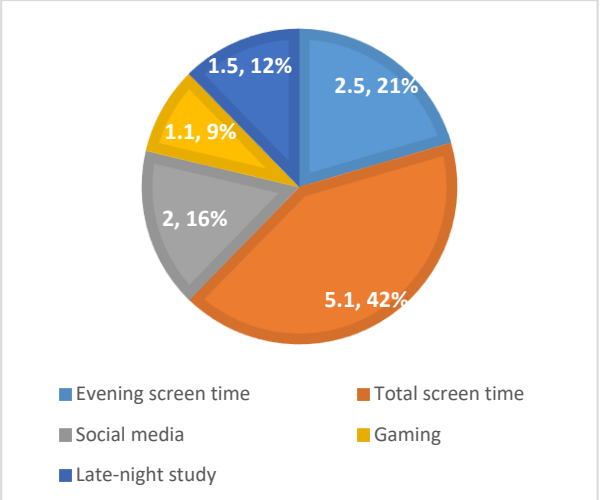

Figure 3: Technology use behavioral patterns among secondary school students. Continuous variables are presented as mean hours per day and categorical variables as percentages (n=500).

Smartphone use around bedtime was particularly common. 60.0% of students reported using their smartphones while in bed, 68.8% used a smartphone within 30 minutes of falling asleep, and 72.2% kept their smartphone beside the bed during sleep (Figure 4). These findings demonstrate widespread bedtime smartphone

exposure and provide an important behavioral context for the observed prevalence of insufficient sleep and poor sleep quality among the study participants.

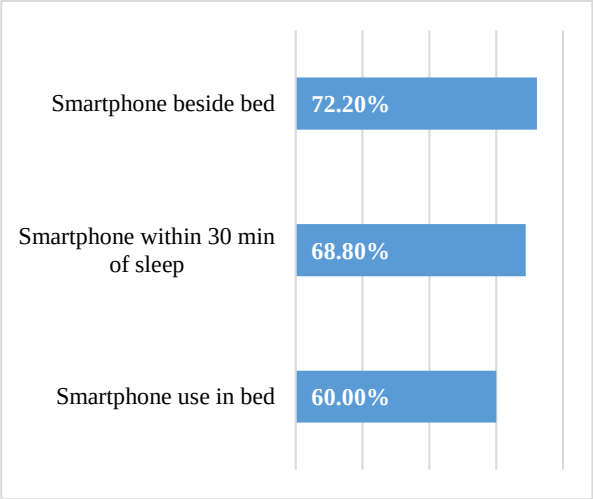

Figure 4: Evening behavioral patterns among secondary school students. Continuous variables are presented as mean hours per day and categorical variables as percentages.

Students with poor sleep quality had significantly greater evening screen time, total daily screen exposure, social media use, and late-night study hours than those with good sleep quality (all $p<0.001$, Table 4). Poor sleep quality was also significantly associated with smartphone use in bed, high academic workload, high perceived stress, daytime napping, evening caffeine consumption, and shorter school-night sleep duration. In contrast, students achieving ≥60 minutes of daily physical activity were less likely to have poor sleep quality ($p=0.003$).

Table 4: Comparison of demographic, behavioral, and lifestyle characteristics according to sleep quality

Variable	Good sleep PSQI ≤5 (n=325)	Poor sleep PSQI >5 (n=175)	Test statistic	p-value
Age, years	15.6 ± 1.2	16.1 ± 1.1	t=4.31	<0.001
Female sex	164 (50.5%)	106 (60.6%)	χ^2=4.59	0.032
Urban residence	198 (60.9%)	127 (72.6%)	χ^2=6.98	0.008
Evening screen time, h	2.2 ± 0.9	3.1 ± 1.0	t=9.88	<0.001
Total screen time, h/day	4.6 ± 1.7	6.0 ± 1.9	t=8.00	<0.001
Smartphone use in bed	177 (54.5%)	123 (70.3%)	χ^2=12.37	<0.001
Social media, h/day	1.7 ± 1.0	2.6 ± 1.3	t=8.28	<0.001
Late-night study, h	1.4 ± 0.7	1.7 ± 0.7	t=4.68	<0.001
High academic workload	136 (41.8%)	102 (58.3%)	χ^2=13.25	<0.001
High perceived stress	65 (20.0%)	72 (41.1%)	χ^2=25.04	<0.001
Physical activity ≥60 min/day	116 (35.7%)	40 (22.9%)	χ^2=9.01	0.003
Daytime nap	124 (38.2%)	90 (51.4%)	χ^2=8.53	0.003
Caffeine after 6 pm	69 (21.2%)	68 (38.9%)	χ^2=18.02	<0.001
School-night sleep duration, h	7.2 ± 0.9	6.1 ± 0.9	t=12.85	<0.001

Figure 5 demonstrates a clear unfavorable behavioral pattern among students with poor sleep quality. Compared with students reporting good sleep, those with poor sleep had greater evening and total screen exposure, more social media use, shorter school-night sleep, and higher levels of perceived stress. Smartphone use in bed was also substantially more frequent among students with poor sleep quality.

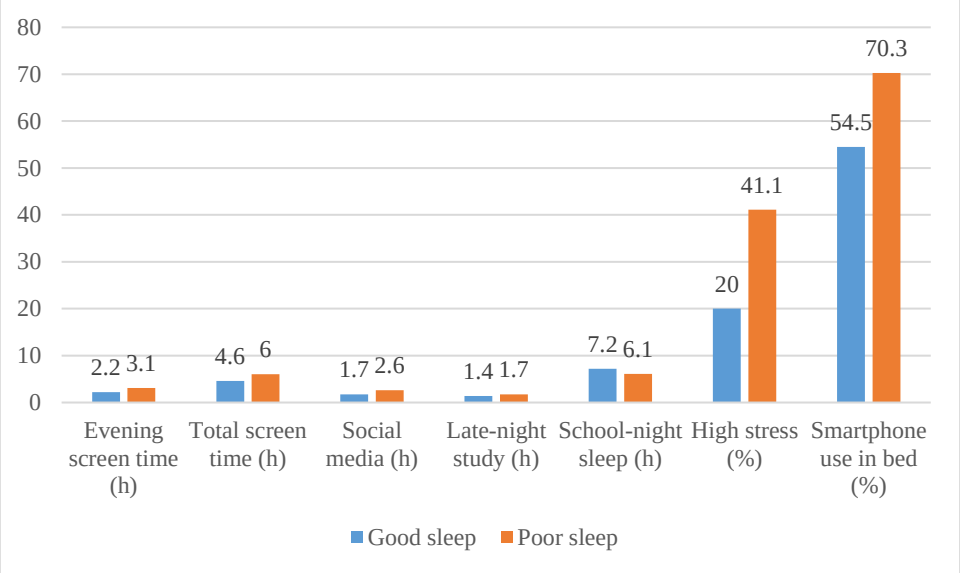

Figure 5: Comparison of sleep-related behavioral and psychosocial characteristics between students with good sleep quality (PSQI ≤5) and poor sleep quality (PSQI >5).

Evening screen time showed a significant inverse correlation with sleep duration ($r=-0.42$, $p<0.001$) and a positive correlation with PSQI score ($r=0.39$, $p<0.001$), indicating that greater evening exposure was associated with shorter and poorer-quality sleep (Table 5). Perceived stress demonstrated a similarly important relationship, being inversely correlated with sleep duration ($r=-0.29$, $p<0.001$) and positively correlated with PSQI score ($r=0.41$, $p<0.001$). Social media use, smartphone use in bed, and late-night studying also showed significant associations with both sleep outcomes.

Table 5: Correlation between screen use, stress, academic workload, and sleep parameters

Variable	Sleep duration	PSQI score
Evening screen time	$r = -0.42$, $p<0.001$	$r = 0.39$, $p<0.001$
Total screen time	$r = -0.35$, $p<0.001$	$r = 0.32$, $p<0.001$
Social media use	$r = -0.31$, $p<0.001$	$r = 0.35$, $p<0.001$
Smartphone use in bed	$r = -0.28$, $p<0.001$	$r = 0.30$, $p<0.001$
Late-night study hours	$r = -0.21$, $p<0.001$	$r = 0.19$, $p<0.001$
Academic workload	$r = -0.18$, $p<0.001$	$r = 0.24$, $p<0.001$
Perceived stress	$r = -0.29$, $p<0.001$	$r = 0.41$, $p<0.001$
Physical activity	$r = 0.16$, $p<0.001$	$r = -0.14$, $p=0.002$

Multivariable linear regression identified evening screen time as a significant independent predictor of shorter school-night sleep ($\beta=-0.30$, $p<0.001$, Table 6). Smartphone use in bed, social media use, late-night studying, high academic workload, and high perceived stress were also independently associated with reduced sleep duration, whereas regular physical activity was positively associated with sleep duration. The overall model was statistically significant (adjusted $R^2=0.34$, $p<0.001$).

Table 6: Multiple linear regression analysis of factors associated with school-night sleep duration

Predictor	β coefficient	SE	95% CI	p-value
Evening screen time (per hour)	−0.30	0.07	−0.44 to −0.16	<0.001
Smartphone use in bed	−0.42	0.12	−0.66 to −0.18	0.001
Social media use (per hour)	−0.14	0.05	−0.24 to −0.04	0.006
Late-night study (per hour)	−0.20	0.08	−0.36 to −0.04	0.014
High academic workload	−0.25	0.11	−0.47 to −0.03	0.025
High perceived	−0.31	0.12	−0.55 to	0.012

stress			−0.07	
Physical activity ≥60 min/day	+0.28	0.11	0.06 to 0.50	0.013
Female sex	−0.16	0.10	−0.36 to 0.04	0.117
Age	−0.09	0.05	−0.19 to 0.01	0.076

After adjustment for potential confounders, high perceived stress was one of the strongest independent predictors of poor sleep quality (AOR=2.42, 95% CI: 1.56–3.76, p<0.001), followed by evening screen exposure of ≥2 hours (AOR=2.31, 95% CI: 1.51–3.53, p<0.001). Smartphone use in bed, high academic workload, greater social media use, late-night studying, and evening caffeine consumption were also independently associated with increased odds of poor sleep quality, whereas ≥60 minutes of daily physical activity was associated with lower odds (AOR=0.64, 95% CI: 0.41–0.99, p=0.046, Table 7).

Table 7: Multivariable Logistic Regression for Poor Sleep Quality

Predictor	Adjusted OR	95% CI	p-value
Evening screen time ≥2 h	2.31	1.51–3.53	<0.001
Smartphone use in bed	1.86	1.22–2.84	0.004
Social media use ≥2 h/day	1.74	1.15–2.63	0.009
Late-night study ≥2 h	1.51	1.00–2.29	0.049
High academic workload	1.68	1.11–2.54	0.014
High perceived stress	2.42	1.56–3.76	<0.001
Daytime naps	1.42	0.96–2.11	0.079
Physical activity ≥60 min/day	0.64	0.41–0.99	0.046
Caffeine after 6 pm	1.58	1.00–2.48	0.049
Female sex	1.31	0.89–1.93	0.169
Age ≥16 years	1.43	0.96–2.13	0.077

Discussion

The present study found that a substantial proportion of secondary students slept less than the recommended 8 hours on school nights, with nearly one-third reporting poor sleep quality. These findings are consistent with previous Chinese research in Nepal, where students reported poor sleep associated with academic and mental stress (Wang et al., 2023). Our results also demonstrated strong associations between evening usage habits—such as late-night screen exposure and smartphone use in bed—and poor sleep outcomes. This aligns with prior studies indicating that evening technology use negatively impacts sleep duration and quality (Ming et al., 2011; AlShareef, 2022). The mechanisms include circadian phase delay, melatonin suppression, and psychological stimulation from online activities (Swope et al., 2023).

Consistent with Okano et al. (2019), this study highlights that not only sleep duration but also sleep consistency and quality matter for academic performance. Students with irregular sleep patterns, such as significant differences between school nights and weekends, reported lower well-being and concentration levels.

School start times emerged as another influential factor. Early school schedules contributed to shorter sleep duration, forcing students to wake up before completing sufficient rest (Singh et al., 2023). Policies allowing later start times could help mitigate sleep deprivation in adolescents.

The findings carry important implications. Educational authorities, parents, and policymakers should work to reduce evening screen exposure, regulate homework load, and encourage sleep hygiene practices. Awareness campaigns in schools could promote healthy routines and emphasize the risks of late-night technology use.

However, this study has limitations. Being cross-sectional, causality cannot be established; it is possible that poor sleepers are more inclined to use devices at night. Despite these, the findings strengthen the growing evidence that adolescent sleep is strongly shaped by usage habits and structural factors such as school timing.

Additional evidence from systematic reviews and observational studies supports the relationship

between electronic media use and sleep problems in adolescents. A systematic review reported that electronic media use is associated with adverse sleep outcomes among children and adolescents (Lund et al., 2021). Similarly, research on adolescent sleep has linked media exposure with reduced sleep efficiency, while evidence from school-aged adolescents indicates that greater screen use is associated with shorter sleep duration, daytime sleepiness, and poorer academic outcomes (Fobian et al., 2016; Pérez-Chada et al., 2023). A study of school-going adolescents in Kerala also documented a high burden of sleep deprivation, further supporting the concern that insufficient sleep is common among adolescents (Zacharia et al., 2022).

Smartphone-specific evidence also strengthens the present findings. A systematic literature review found that smartphone use can negatively influence adolescent sleep, particularly when use occurs close to bedtime (de Sá et al., 2023). Cross-sectional evidence from India likewise reported an association between smartphone screen time and sleep problems among adolescents and young adults (The association of smartphone screen time with sleep problems among adolescents and young adults, 2022). Experimental evidence further demonstrates that blue light emitted by electronic devices can suppress melatonin in a dose-dependent manner, providing a biological explanation for why evening device exposure may delay sleep (West et al., 2011).

School timing and sleep-related interventions are additional factors that deserve attention. Delayed school start times have been associated with better sleep, daytime functioning, and life satisfaction among adolescents, while intervention research suggests that school-based approaches can help prevent sleep deficit (Chan et al., 2018; Bauducco et al., 2020). These findings are consistent with the present study's observation that early school schedules may contribute to insufficient sleep and support consideration of later school start times as part of broader adolescent sleep-health strategies. Previous work has also examined the impact of media on adolescent sleep quality, reinforcing the importance of addressing technology use alongside school and lifestyle factors (Koreti & Eske, Saxena, 2017).

Strengths and Limitations

This study has several strengths. It included a relatively large and representative sample of secondary school students, which enhances the reliability and generalizability of the findings. The study assessed both sleep duration and sleep quality while also examining multiple technology and device-use variables, providing a more comprehensive evaluation of factors potentially associated with adolescent sleep. Furthermore, adjustment for relevant covariates, including gender, grade level, and other participant characteristics, allowed for more robust estimates of the observed associations.

Several limitations should also be considered. The study relied primarily on self-reported information, which may have introduced recall and reporting bias. The cross-sectional study design limits the ability to establish temporal relationships or draw conclusions regarding causality between technology use and sleep outcomes. In addition, some potentially important confounding factors, such as underlying health conditions, family environment, exposure to light, dietary habits, and caffeine intake, may not have been measured or adequately controlled. Finally, the absence of objective sleep measurements, such as actigraphy or polysomnography, may have limited the accuracy of the assessment of sleep duration and quality.

Future Perspective

Longitudinal studies should follow students over time to determine whether changes in technology-use patterns lead to changes in sleep duration and sleep quality. Intervention studies, such as reducing screen exposure before bedtime, implementing sleep-education programs, or modifying school start times and homework schedules, could help establish whether such measures improve sleep and academic outcomes. Future research should also incorporate objective sleep measures, including actigraphy and wearable devices, to validate self-reported sleep outcomes. In addition, studies should examine cultural, social, and environmental factors, including urban–rural differences, socioeconomic status, device accessibility, and family environment, as potential moderators. Psychological factors such as stress, anxiety, and mental health should also be explored as potential mediators or modifiers of the relationship between

technology use and sleep.

Conclusion

This study found that many secondary students had insufficient sleep and poor sleep quality. Evening screen exposure, device use in bed, and late-night studying were associated with poorer sleep outcomes. These findings highlight the need for improved sleep hygiene, reduced nighttime device use, and school- and family-based strategies to support healthier sleep habits among adolescents.

Declarations

Ethical Considerations

The study adhered to ethical research standards. Informed consent was obtained from all participants, including teachers, students, and parents/community members. Participation was voluntary, and respondents were assured of confidentiality and anonymity. No identifying information was recorded or disclosed.

Authors' Contributions

Both authors contributed equally to Conceptualization and Supervision, Methodology, Investigation, Data Collection, Data Analysis, Writing – Original Draft, Writing, Review and Editing.

Conflict of Interest

The authors declare no conflict of interest.

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