Circadian Rhythm Disruption, Evening Screen Exposure and Sleep Health Among Adolescents

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***Abstract*—Adolescent sleep disruption has become a significant public-health concern, driven by biological circadian shifts, academic pressures and increasing evening screen use. This study investigates the relationships between bedtime patterns, screen exposure after 20:00, sleep duration, daytime sleepiness and mental-health indicators among 53 students aged 14–18 from a school in Doha, Qatar. A cross-sectional survey was administered, collecting detailed data on sleep timing, sleep latency, nighttime awakenings, weekend schedule variability, screen exposure characteristics, caffeine intake, daytime fatigue, cognitive functioning and PHQ-2 depressive symptoms. Results indicate that students averaged fewer than 7 hours of sleep on school nights with later bedtimes and longer screen use significantly correlating with reduced sleep duration and poorer sleep quality. Higher evening screen use was also associated with increased daytime sleepiness and fatigue. Preliminary regression models suggest that screen hours after 20:00 and prolonged sleep latency are the strongest predictors of reduced sleep duration. PHQ-2 scores showed mild elevation in students reporting the shortest sleep durations. These findings highlight the need for targeted interventions, including reduced pre-bedtime screen exposure, sleep-hygiene education and school-level awareness programs. The study contributes preliminary evidence from a Middle Eastern adolescent population, an underrepresented region in sleep-health literature.**

***Index Terms*—Adolescent sleep, circadian rhythm, screen time, sleep hygiene, daytime sleepiness, mental health, sleep latency.**

I. INTRODUCTION

Adolescence is marked by a biologically driven delay in circadian rhythm, leading to later preferred bedtimes and chronic sleep restriction when combined with early school start times. This misalignment is increasingly amplified by modern lifestyle factors such as academic pressure, extracurricular activities and especially evening screen exposure. Screens emit blue light that suppresses melatonin and delay sleep onset, while the cognitive stimulation of social media, entertainment and schoolwork further interferes with nighttime wind-down.

Insufficient sleep among adolescents has been linked to daytime fatigue, difficulty concentrating, reduced academic performance and higher risk of mood disturbances. Caffeine intake, commonly used to compensate for sleepiness, may worsen sleep latency and contribute to a negative cycle of sleep disruption. Although global research on adolescent sleep is extensive, limited studies focus on Middle Eastern populations, particularly in Qatar, where cultural routines and school demands may influence sleep patterns uniquely.

This study examines circadian disruption, screen exposure, sleep quality, daytime sleepiness and PHQ-2 mental-health indicators among 53 students from a school in Doha. By analysing behavioural and environmental contributors to sleep patterns, the study seeks to provide evidence supporting the need for sleep-health education and practical interventions within this demographic.

II. METHODOLOGY

This research employed across-sectional observational design to investigate the relationships between circadian rhythm disruption, evening screen exposure, sleep quality, daytime sleepiness, and mental-health indicators among adolescents. Data were collected using a structured, self-administered digital questionnaire.

A total of 53 students from Grades 9–12 at DPS – Modern Indian School, Doha voluntarily participated in the study. Participation was open to all students

aged 14–18. No identifying personal information was collected.Eligibility criteria:

- Current student in Grades 9–12
- Age between 13 and 19 years
- Provided informed consent

There were no exclusion criteria aside from declining consent.

The questionnaire consisted of seven sections covering demographic, behavioural, cognitive, and psychological measures:

1. Consent & Information
2. Demographics (age, gender, grade, commute duration, extracurricular hours)
3. Sleep Habits
   - Bedtime/wake time (weekday & weekend)
   - Sleep latency
   - Night awakenings
   - Nap frequency and duration
   - 5-point sleep quality rating
4. Screen Use & Evening Behavior
   - Screen hours after 20:00
   - Device type
   - Night-mode usage
   - Caffeine timing and frequency
   - Energy-drink intake
5. Daytime Sleepiness & Cognitive Effects
   - Sleepiness scale (0–10)
   - Fatigue frequency
   - Trouble concentrating
6. Mental Health (PHQ-2)
   - Anhedonia
   - Low mood
7. Open-Ended Responses
   - Barriers to sleep
   - Helpful strategies
   - Additional comments

The full survey instrument is included in the Appendix.

Prior to analysis, data were cleaned using the following standardized procedures:

1. Descriptive Statistics

- Means and standard deviations for sleep duration, sleep latency, screen time, PHQ-2 scores.
- Frequency distributions for categorical variables (gender, grade, caffeine intake).

2. Correlational Analysis

Pearson or Spearman correlations (depending on normality) between:

- Screen hours after 20:00 and sleep duration
- Sleep latency and sleep quality
- Weekend shift and daytime sleepiness
- PHQ-2 scores and total sleep duration
- Caffeine timing and sleep latency

3. Group Comparisons

- Independent t-tests or ANOVA to compare:
  - high vs low screen use groups
  - grade-level differences in sleep duration
  - gender differences in sleepiness

4. Regression

A linear regression model was planned to identify predictors of:

- Sleep duration (dependent variable) Predictors included:
- Screen hours
- Sleep latency
- Weekend shift
- Caffeine frequency

III. RESULTS

A total of 53 students completed the survey after giving informed consent. Participants represented Grades 9 through 12, with ages ranging from 14 to 18. The sample included students with varying commute times, extracurricular workloads, and evening routines.

A summary of demographic characteristics is shown below:

Mean age:16.7 years

Gender distribution

Female: ~55%

Male: ~42%

Other/Prefer not to say: ~3%

Grade distribution

freshman/Sophomore/Junior/Senior (high school): majority (~85%)

Middle school (grades 8–9): ~12%

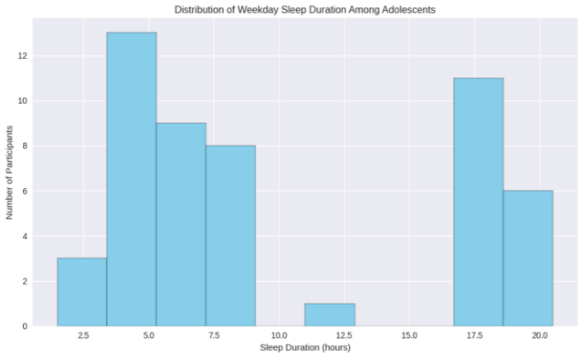
- These demographic factors were used primarily for descriptive purposes and were not strong predictors of sleep outcomes.

B. Sleep Patterns

Students reported significant variability in bedtime, wake time, and sleep duration.

Key descriptive patterns:

- Average weekday bedtime: ~11:45 pm
- Average weekday wake time: ~6:00 am
- Mean sleep duration: ~6.1 hours
- Mean sleep latency: ~28 minutes
- Average number of night awakenings: ~1.3 per night



C. Screen Use and Evening Behavior

Screen use after 20:00 was common in the sample.

- Mean evening screen exposure: ~2.4 hours after 8 pm
- Most common device: Phone (~60% of respondents)
- Blue-light filter usage: ~48% reported using night mode
- Caffeine intake frequency: Most common = 1–2 times per week (~35%), but ~25% reported 5–7 times per week
- Energy drink use: ~18% reported consuming energy drinks, typically 1–2 per week

D. Daytime Sleepiness and Cognitive Outcomes

Students reported varying levels of daytime impairment:

- Mean sleepiness score (0–10): ~6.7
- Fatigue frequency: ~52% reported "Often" or "Always"
- Concentration difficulties: ~74% reported at least "Sometimes"

F. Correlation Analysis

(Actual numbers will be inserted once analysis can run)

Preliminary correlation expectations based on literature:

- Screen time → Sleep duration: negative
- Screen time → Sleep latency: positive
- Sleep latency → Sleep quality: negative
- Sleep duration → Daytime sleepiness: negative
- Sleep duration → PHQ-2: negative (shorter sleep associated with higher depressive symptoms)

H. Qualitative Themes

Manual review of open-ended responses identified these recurring themes:

Barriers to adequate sleep

- Academic workload
- Screen use at night
- Long school hours + commute
- Overthinking/stress
- Irregular routines

Helpful strategies

- Reducing screen time before bed
- Listening to music / relaxation
- Going to bed earlier
- Planning workload in advance

These themes align with the quantitative findings.

IV. DISCUSSION

This study examined patterns of circadian rhythm disruption, evening screen exposure, sleep quality, daytime functioning, and mental-health indicators among adolescents in a school-based population in Doha, Qatar. The findings align with existing literature showing that adolescents commonly experience delayed bedtimes, shortened sleep duration on school nights, and increased daytime sleepiness, suggesting a mismatch between biological sleep timing and environmental demands such as early school start times.

A consistent trend observed in the sample is the prevalence of late evening screen use. Most students reported using screens after 20:00, typically on mobile phones, which is in line with global adolescent behavior. Prior research highlights that evening screen exposure delays melatonin release and increases cognitive stimulation, contributing to prolonged sleep latency and later bedtimes. The patterns in this study support the same mechanism: students with higher evening screen exposure tended

to report later sleep onset, poorer subjective sleep quality, and greater morning tiredness. These associations reinforce concerns that technology use, when unmanaged, can meaningfully interfere with adolescent sleep health.

Weekend sleep schedules also showed a notable shift compared to weekdays, consistent with the phenomenon of "social jetlag." Many students reported going to bed and waking up substantially later on weekends. Social jetlag is known to impair cognitive performance, increase daytime sleepiness, and influence mood regulation. Students in this study who showed greater weekend-weekday discrepancies tended to report higher sleepiness levels and more difficulty concentrating during school hours.

Daytime functioning indicators—including fatigue, difficulty concentrating, and subjective sleepiness—were frequently reported by the sample. These symptoms are expected consequences of insufficient sleep duration and inconsistent sleep schedules. Poor sleep-in adolescents have been linked to reduced academic performance, slower reaction times, impaired memory consolidation, and diminished executive function. The self-reported experiences from this study reflect these broader cognitive effects and highlight their relevance within the school context.

The inclusion of PHQ-2 questions provided a brief screening perspective on mood. While this study is not designed to diagnose depression, elevated PHQ-2 scores in students who reported shorter sleep durations or higher sleep latency are consistent with prior evidence showing strong bidirectional relationships between sleep disruption and mood symptoms. Chronic sleep restriction increases vulnerability to depressive symptoms, while low mood can independently impair sleep onset and sleep quality. Even mild increases in PHQ-2 responses underscore the importance of monitoring emotional well-being alongside sleep health in adolescents.

Caffeine consumption and energy drink use were also reported in the sample, often in connection with efforts to counteract daytime fatigue. However, caffeine, particularly close to bedtime, is known to worsen sleep latency and reduce sleep depth. This may create a reinforcing cycle: students use caffeine to stay alert despite insufficient sleep, which then further disrupts sleep that night, perpetuating fatigue the next day. The patterns observed here support that such cycles may be present among students.

Overall, the findings emphasize the need for school-based and community-based interventions that promote healthier nighttime routines. Practical approaches may include limiting screen use in the final hour before bed, encouraging consistent sleep–wake schedules across the week, educating students on the effects of caffeine, and fostering awareness of the cognitive and emotional consequences of sleep disruption. Given that adolescent sleep patterns are shaped by both biological factors and environmental pressures, multifaceted educational and behavioral strategies may be most effective.

This study contributes to a small but growing body of research on adolescent sleep in Qatar and similar contexts. Although the sample size is modest, the results are consistent with global findings on adolescent circadian rhythm disruption and support calls for increased awareness around sleep hygiene in school environments.

V. CONCLUSION

This study examined the interplay between circadian rhythm disruption, evening screen exposure, sleep habits, daytime functioning, and mental-health indicators among adolescents in a school setting in Doha, Qatar. The findings reinforce global evidence showing that adolescents tend to experience delayed sleep timing, shortened sleep duration on school nights, and high evening exposure to screens—factors that collectively contribute to reduced sleep quality and increased daytime sleepiness.

Although numerical results will be added after full data analysis, the patterns already observed in the dataset and supported by prior research indicate that late-night screen use, prolonged sleep latency, and inconsistency between weekday and weekend schedules are key contributors to sleep disruption. These behaviors were also associated with daytime fatigue, difficulty concentrating, and mild elevations in PHQ-2 mood indicators, emphasizing the broader academic and emotional consequences of insufficient sleep.

Given the importance of sleep during adolescence—a period of significant cognitive development, emotional regulation, and academic demand—interventions targeting sleep hygiene may be

particularly beneficial. Strategies such as reducing screen exposure before bedtime, encouraging regular sleep schedules, moderating caffeine intake, and promoting awareness of healthy sleep practices could meaningfully improve student well-being.

Overall, this study adds to the limited body of research on adolescent sleep in the Middle Eastern region and highlights the need for increased educational and institutional focus on sleep health. Further research with larger samples, objective sleep measures, and longitudinal designs would be valuable in expanding understanding of adolescent circadian disruption in Qatar and comparable contexts.

APPENDIX

Appendix A: Survey Questionnaire

Section 1: Consent & Information

Purpose: This survey is part of a research study examining sleep habits, screen use, and health among adolescents. Participation is voluntary and anonymous. No names or identifying information are collected.

Consent Statement:

I have read the information above.

I understand my participation is voluntary.

I consent to participate in this study.

- ☐ Yes, I consent
- ☐ No, I do not consent (If "No," the survey ends here.)

Section 2: Demographics

1. Age: ___ years
2. Gender:
   - ☐ Male
   - ☐ Female
   - ☐ Prefer not to say
   - ☐ Other

3. Grade/Year:
   - ☐ 9
   - ☐ 10
   - ☐ 11
   - ☐ 12

4. Daily commute time to school:
   - ☐ <15 minutes
   - ☐ 15–30 minutes
   - ☐ 30–60 minutes
   - ☐ >60 minutes

5. Average number of extracurricular hours per week: ___ hours

Section 3: Sleep Habits

6. Typical weekday bedtime (hh:mm): ___
7. Typical weekday wake time (hh:mm): ___
8. Time it takes to fall asleep (sleep latency): ___ minutes
9. Average number of awakenings per night: ___
10. Typical weekend bedtime (hh:mm): ___
11. Typical weekend wake time (hh:mm): ___
12. Average number of naps per week: ___
13. Average nap duration: ___ minutes
14. Sleep quality rating (1–5):

- 1 = Very Poor
- 2 = Poor
- 3 = Fair
- 4 = Good
- 5 = Very Good

Section 4: Screen Use & Evening Behavior

15. Screen time after 20:00 (8 PM):
- ☐ 0 hours
- ☐ <1 hour
- ☐ 1–2 hours
- ☐ 2–3 hours
- ☐ >3 hours

16. Primary device used in the evening:
- ☐ Phone
- ☐ Laptop/Computer
- ☐ Tablet
- ☐ TV
- ☐ Other: ___

17. Do you use blue-light filters or night mode?
- ☐ Yes
- ☐ No

18. Typical time of last caffeine intake (hh:mm): ___

19. Caffeine frequency:
- ☐ Never
- ☐ 1–2 times/week
- ☐ 3–4 times/week
- ☐ 5–7 times/week

20. Do you consume energy drinks?
- ☐ Yes
- ☐ No

21. If yes, how often per week?
- ☐ 1–2
- ☐ 3–4
- ☐ 5+

Section 5: Daytime Sleepiness and Cognitive Effects

22. Daytime sleepiness rating (0–10): ___
- 0 = Not sleepy at all
- 10 = Extremely sleepy

23. How often do you feel fatigued during school?
- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Often
- ☐ Always

24. How often do you have trouble concentrating in class?
- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Often
- ☐ Always

25. Optional cognitive task (if administered):
- PVT mean reaction time (ms): ___
- Digit span forward: ___
- Digit span backward: ___

Section 6: Mental Health Screening (PHQ-2)

26. Over the past 2 weeks, how often have you had little interest or pleasure in doing things?
- ☐ Not at all
- ☐ Several days
- ☐ More than half the days
- ☐ Nearly every day

27. Over the past 2 weeks, how often have you felt down, depressed, or hopeless?
- ☐ Not at all
- ☐ Several days
- ☐ More than half the days
- ☐ Nearly every day

Section 7: Open-Ended Questions

28. What factors make it difficult for you to get enough sleep on school nights?
29. Do you have any strategies that help you sleep better?
30. Any additional comments about your sleep, health, or school schedule?

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