Quality of Sleep Among Bedtime Smartphone Users

Bindu Krishnan, Rama Krishna Sanjeev[1], R. G. Latti

Department of Physiology, Rural Medical College, Loni, Pravara, Maharashtra, India, [1]Department of Pediatrics, Rural Medical College, Loni, Pravara, Maharashtra, India

Abstract

Background: Exposure to light from viewing devices at night disturbs the circadian rhythm, especially sleep. The study aimed to assess (a) extent to which smart phones are used by medical undergraduate students during bedtime and to find their quality of sleep (b) the association of quality of sleep and cell phone variables. **Methods:** A cross sectional observational study was conducted among 450 medical undergraduate students. The participants completed Pittsburgh Sleep Quality Index (PSQI) questionnaire and a validated semi structured questionnaire consisting of demographic details and cell phone variables. **Results:** By dividing the subjects into three groups according to their usage (Group I <1 hour, Group II 1 to 2 hours, Group III >2 hours), Group III respondents had significant prolonged sleep latency, reduced sleep duration, sleep inefficiency and daytime sleep disturbances ($P < 0.05$). Lack of awareness about night shift mode, lying posture use while using phone during bedtime correlated with poor quality sleep ($P < 0.05$). **Conclusions:** Awareness about the negative impact of evening exposure to viewing devices on sleep and health should be emphasized.

Keywords: *Blue light, medical students, PSQI scale, sleep quality, smartphones*

Introduction

In the past few decades there has been a decline in the sleep duration among young adults. Good quality sleep, as required in the medical profession, is vital for optimal neurocognitive and psychomotor performances.[1] A global literature review shows higher prevalence of poor quality sleep among Medical students as compared to other university students or the general population.[2,3] This could be attributable to huge academic load, long hours of clinical duties and lifestyle choices. Sleep deprivation can negatively impact physical, social, and psychological health. Memory processing, metabolite clearance, immune restoration are some of the important functions of sleep.[4]

An array of sleep factors are known to build up in the brain during wakefulness and they are known to dissipate during sleep and these factors are known to be responsible for the homeostatic process. The suprachiasmatic nuclei (SCN) are the main organs responsible for the circadian rhythm. The classical photoreceptors rods and cones are responsible for image forming vision, but ipRGCs (intrinsically photosensitive retinal ganglion cells) that express melanopsin are most important for the non-image forming photoreception and they regulate circadian photic entrainment, pupillary light response, and other important biological functions.[5] Synchronization of homeostatic and circadian regulation are important for the quality, quantity, and timing of sleep. Blue light of around 460 nm spectrum, suppresses melatonin, and affects human circadian clock.[6] Source of this blue light can be, light from an artificial light source such as blue-enriched LED lamp, LED backlight for LCD, organic light emitting diodes, computer screens, and from the smartphones monitor.

A recent study in America showed that 90% of young adults under 30 used some technological device in the hour before bed.[7] A recent review of literature in which the association between youth screen media use and sleep was assessed, almost 90% studies reported delayed sleep time and also decreased total sleep duration among bedtime media users.[8] People exposed to blue light at night can have increased incidence of obesity, diabetes, sleep, psychiatric, and cardiovascular disorders and cancers due to epigenetic changes.[9] In

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Address for correspondence:
Dr. Rama Krishna Sanjeev, Department of Pediatrics, Rural Medical College, Pravara Institute of Medical Sciences, Loni (BK), Rahata Taluk, Ahmednagar - 413 736, Maharashtra, India.
E-mail: rksanjeev88@yahoo.com

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this current study we tried to find out the extent to which smartphones are used during bedtime (self-reported time; the time they decided to go to sleep) by dividing the subjects into three groups according to their usage (Group I <1 hour, Group II 1 to 2 hours, Group III >2 hours) and to find if there is a difference in the quality of sleep among these groups and association of sleep with other cell phone variables.

Methods

This cross-sectional observational study was conducted among 450 medical undergraduate students residing in the Medical College hostel. Participants were selected using stratified cluster sampling technique. Data collection was done from December 2017 to May 2018. Institutional ethical clearance was obtained before the commencement of the study. Written consent was got from all the participants. Literature reports sleep disorders due to bedtime smartphone use between 15% to 35%. Taking 15% population proportion at 0.05 level, with 80% power of difference and an alpha error of 5%, the sample size was calculated as 430. To prevent sample loss the sample size was taken as 450. Medical students using smartphones for more than one year and willing to participate in the study were included in the study. In this study we tried to find out the extent to which smartphones are used during bedtime (self-reported time and usage) this was elicited from the respondents in the questionnaire given to them. The subjects were divided into three groups according to their usage (Group I <1 hour, Group II 1 to 2 hours, Group III >2 hours) and to find if there is a difference in the quality of sleep among these groups and association of sleep with other cell phone variables. Student taking medication affecting sleep or suffering from psychiatric, neurological, and sleep disorders were excluded.

Demographic information

A semi structured validated questionnaire was used consisting of demographic details like age, sex, height, weight, and BMI. Cell phone variables like make of phone, time spent on smartphone at bedtime (calculated as hours per day) and mode while sleeping were included. The students' awareness of blue light emissions, night mode, and posture while using the phone at nights was asked. The questionnaire was first validated on 40 medical students. Relevant modifications were made and incorporated thereafter in the 450 study respondents.

Pittsburgh sleep quality index (PSQI)

The Pittsburgh Sleep Quality Index (PSQI) questionnaire assesses the study subjects in the last one month. Answering modes mostly comprise of a four-point Likert scale. In this scale, seven domains which include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction are evaluated. Total scores range from 0 to 21, with higher scores indicating more sleep problems. The English version instrument's internal consistency and validity were confirmed by Carpenter and Andrykowski (Cronbachs $\alpha = 0.80$).[7] A global score of ≥5 indicates poor sleep quality over the past 1 month.

Statistical analysis

Data coding and entry was done in Microsoft Excel spread sheets. Descriptive and inferential statistical analysis was done by using SPSS version 21 software. In descriptive statistics, Mean, Standard deviation, Proportion and Frequency were used. Inferential statistical analysis was done using Chi-square test, Mann Whitney U test. A 5% level of significance was considered significant ($P < 0.05$).

Results

A total of 450 students participated in the study. Data of 17, being incomplete, were removed.

Table 1 shows the sample distribution by three groups based on duration in hours of smartphone use at bedtime and gender. Subjects were in the age group between 18 to 25 years, with an average of 19.98 years (SD = 1.23) for males and 20.03 years (SD = 1.36) for females.

Table 2 shows components of PSQI scale among the three groups of smartphone users.

Global PSQI score: Sixty two percent of the total respondents had a global PSQI score of ≥5 with maximum among group III subjects with 72%.

Sleep latency: Sleep latency was more in group III with 26% taking more than 60 minutes to sleep.

Sleep duration: The normal sleep duration is considered as 7 hours in this scale. Sleep duration was less than 5 hours in 11% of group III subjects in comparison to 3% in group I. Only 12% of group III subjects had more than 7 hours of sleep when compared to 20% in group I.

Sleep efficiency: Sleep efficiency of less than 65% was seen among 2.56%, 5.26%, and 19.14% of groups I, II, and III, respectively.

Daytime dysfunction: Among group III respondents, 14.89% had a summated score of 3(very big daytime dysfunction problem) when compared to 9.82% in group I. Difficulty in engaging in daily activities was the most common daytime

Table 1: Sample distribution by group and gender

Sample characteristics		Students *n* (%)
Using smartphones during bedtime		
Group I	using <1 h	234 (54.73)
Group II	using 1 to 2 h	152 (35.10)
Group III	using >2 h	47 (10.85)
Gender	Male	172 (39.72)
	Female	261 (60.27)

dysfunction. Group III had 17% respondents using some form of medication once a week.

Figure 1 Shows the mean score for Global PSQI was 5.07(SD = 2.42), 5.95 (SD = 2.85), and 7.27(SD = 2.96) in group I, II, and III, respectively.

The most common time at which the respondents went to sleep and lights were off was 24:00 AM. The most common time at which they got up was 07:00 AM. The academic sessions start at 08.00 AM.

Table 3 shows association of cell phone variables with global sleep score:

Cell phone variables like awareness about night shift mode and using the mode, posture used while using phone during bedtime strongly correlated with poor quality sleep ($P < 0.05$).

Discussion

The main objective of this study was to assess the quality of sleep among bedtime smartphone users and to find out the association of sleep with other cell phone variables. In our study, group III respondents (72%) had an overall poor global PSQI score. Bedtime smartphone use was associated with increased sleep latency, reduced sleep duration, sleep inefficiency, and increased daytime sleep disturbances significantly. Lying posture while using the smartphone and awareness about night mode were the other parameters associated with poor sleep quality.

Table 2: Components of PSQI scale among the three groups of smartphone users

Variable	Group I (%)	Group II (%)	Group III (%)	*P*
Subjective sleep quality				
Very good	32.47	28.28	29.78	0.19
Fairly good	59.40	60.52	55.31	
Fairly bad	6.8	11.18	10.63	
Very bad	1.28	00	4.25	
Sleep latency				
<15 min	37.60	27.63	31.91	
15-30 min	38.46	36.18	21.27	0.0001*
31-60 min	19.23	21.05	21.27	
>60 min	4.7	15.13	25.53	
Sleep duration				
>7 h	20.51	10.52	12.76	
6-7 h	58.54	68.42	46.80	0.005*
5-6 h	17.52	18.42	29.73	
<5 h	3.41	2.63	10.63	
Habitual sleep efficiency				
>85%	77.35	56.57	42.57	
75-84%	17.09	28.94	23.40	0.0001*
65-74%	2.99	9.21	14.89	
<65%	2.56	5.26	19.14	
Sleep disturbances	7.26	11.84	8.51	0.51
Use of Sleep medication	5.9	10.52	17	0.24
Daytime dysfunction				
No problem	31.19	41.44	29.78	
Slight problem	41.45	28.28	23.40	0.02*
Somewhat a problem	17.52	19.73	31.91	
Very big problem	9.82	10.52	14.89	
Global PSQI score (>5)	39.74	52.63	72.34	0.02*

According to guidelines recommended by the National Sleep Foundation, a young adult aged 18–25 years requires 7–9 hours sleep every night.[10] An Indian study among university students showed almost 70.9% slept for 4–6 hours at night during college working days.[11] The smartphone with its multiple functions has silently crept into our lives and become a part of it. As early as 1996, Boivin *et al.* had reported low intensity light can affect circadian rhythm.[12] An extensive literature on bedtime use of electronic devices and sleep can be traced during the past decade. Munezawa *et al.* in their study conducted among Japanese adolescents had shown that use of smartphones after lights out was associated with short sleep duration, poor sleep quality, and daytime sleepiness.[13] A cross-sectional study among 9,846 Norwegian adolescents reported that 90% of them use their mobile phone in the hour before going to bed and had self-reported sleep onset latency and sleep deficit.[14] In a recent study, Chang *et al.* established that reading from light emitting devices reduced melatonin level by 55.12 ± 20.12% in contrast to reading a printed book (-18.77 ± 98.57%).[15] A meta- analysis of 20 studies on association between media devices and sleep outcomes, the authors consistently found insufficient sleep duration (OR = 2.17, $P < 0.001$), poor sleep quality (OR = 1.46, $P < 0.01$), and excessive daytime sleepiness (OR = 2.72, $P < 0.01$).[16] The findings are consistent with ours, where group III respondents had significant prolonged sleep latency, shorter sleep duration, reduced sleep efficiency, and daytime sleep disturbances when compared to group I and group II [$P < 0.05$].

Ji Hye Oh *et al.* in their analysis of circadian properties noted that if a smart phone is used in a bright room, the combined effect of light from the smartphone and lighting aggravates the circadian environment.[9] The light source used in the

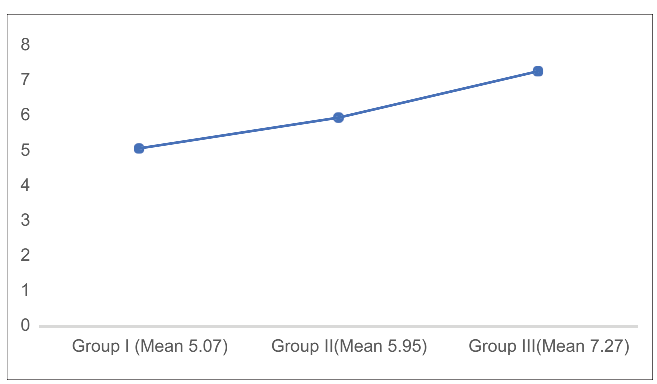

Figure 1: Comparison of Mean (SD) of global score of PSQI among the three groups

Table 3: Association of cell phone variables with Global PSQI sleep score

Cell phone variables	Male *n* (%)	Female *n* (%)	Total *n* (%)	Global PSQI score ≥5 (*n*)	Global PSQI score <5 (*n*)	*P*
No of subjects	172 (39.72)	261 (60.27)	433	207	226	0.055
During sleep mobile is in mode						
Silent	37 (21.51)	76 (29.11)	113 (26.09)	56	57	
Vibratory	48 (27.90)	66 (25.28)	144 (33.25)	70	74	0.94
Flight	05 (2.90)	10 (3.83)	15 (3.46)	7	8	
General	78 (45.34)	83 (31.80)	161 (37.18)	74	87	
Awareness about blue light emitting from mobile phone affecting sleep						
Yes	88 (51.16)	111 (42.52)	199 (45.95)	97	102	0.71
No	80 (46.51)	154 (59.00)	234 (54.04)	110	124	
Awareness about setting the mobile in night shift mode						
Yes	94 (54.65)	93 (35.63)	187 (43.18)	78	109	0.02*
No	80 (46.51)	166 (63.60)	246 (56.81)	129	117	
Posture assumed while using mobile						
Sitting	20 (11.62)	35 (13.40)	55 (12.70)	16	39	0.003*
Lying down	154 (89.53)	224 (85.82)	378 (87.29)	191	187	
Placement of mobile during bedtime						
In the bed	78 (45.34)	173 (66.28)	251 (57.96)	126	125	0.28
Far from the bed but inside bedroom	90 (52.32)	92 (35.24)	182 (42.03)	81	101	
Responding to phone when it rings/gives a messenger alert when you are going to sleep						
Respond to it immediately	86 (50)	113 (43.29)	199 (45.95)	89	110	0.02*
Check it but do not respond	47 (27.32)	87 (33.33)	134 (30.94)	77	57	
Pay no attention but sleep	34 (19.76)	66 (25.28)	100 (23.09)	41	59	

hostel rooms of respondents is 6500K compact fluorescent lamp (CFL). The high color (colder/bluer) temperature of fluorescent light stimulates the non-visual pathway from the eye to various part of the brain that involves the circadian rhythm.[17] In our study the average time at which the lights were switched off in the room is 24 00 hrs. Assuming that lights were switched on at 1800 hrs the length of exposure to bright light would be around 5–6 hours.

Almost 87% of the respondent in our study used lying down posture during smartphone use. Michitaka *et al.* investigated viewing distance of smartphones and concluded that distances were shorter in the lying position than in the sitting posture and they correlated negatively with subjective sleep status.[18] Night shift mode awareness was lacking among 246 respondents with 52% among them having poor quality sleep. The main purpose of using night mode is to reduce the brightness emitted from smartphones to a level below the threshold at which melatonin suppression occurs.

The other reasons where by the bedtime use of smartphones can compromise the quality and quantity of sleep are (1) Displacement of time for sleep for young adults as there is no structured time frame when watching/gaming for pleasure.[19] (2) Evidence suggests that exposure to cell phone radiation can cause sleep disturbances especially reduced REM sleep latency.[20] (3) Sleep can also be affected by the media content.[21] (4) The content of communication, for which phones are used, can itself affect the quality of sleep.

Medical students undergo a prolonged, intensive and strenuous course before they become professionals. Inadequate sleep could further vitiate this and compromise the educational foundations of the practice of medicine among an entire generation of medical professionals. Less than 6–7 hours of sleep every night is known to cause daytime dysfunction, reduced cognitive as well as psychomotor abilities and a diminished academic performance.[22] The importance of good sleep hygiene should be incorporated in the academic programs of undergraduate and post graduate medical students.

Strengths of the study

Very few studies in our country have assessed the sleep quality among bedtime smartphone users with variables like posture, effect of ambient room light, awareness about blue light and night shift mode.

Limitations of the study

(a) Being a cross sectional study, the cause effect relationship could not be established. (b) Quality of sleep was assessed subjectively. Objective measures like melatonin levels, polysomnography for sleep analysis and spectral power distribution of smart phones could not be measured. (c) Sleep disorders have a multifaceted etiology, with medical, social, behavioral (like smoking, caffeine use) and psychological components which were not taken into consideration.

Conclusions

Screen time exposure during bedtime was associated with increased sleep latency, reduced sleep duration, sleep inefficiency, and increased daytime sleep disturbances significantly. This study findings suggest that medical undergraduate students do spend a substantial amount of time with their smartphones during bedtime. Lying posture while using the smartphone and awareness about night mode were the other parameters associated with poor sleep quality.

Ethical approval and consent to participate

The study was approved by ethical committee, Rural Medical College, Loni. The participants had given their written consent before the start of the study.

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Conflicts of interest

There are no conflicts of interest.

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