Original Research Article

Impact of smartphone use on quality of sleep among medical students

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ABSTRACT

Background: Smartphone with its various functionalities has become an essential part of our daily activities and its use has been increasing. This has raised concern about its overuse and addiction especially in students. It is known that poor sleep is very common among medical students; there are many studies on sleep quality and its determinants in medical students but very few relating sleep quality and smartphone addiction. The main objective of this study was to investigate the relationship between smartphone use severity and sleep quality among medical students of KIMS, Hubballi.

Methods: A cross-sectional study on sample of 240 undergraduate medical students KIMS, Hubballi was conducted. Students were assessed using a self-administered questionnaire, Smart phone addiction scale (SAS) and Pittsburgh sleep quality inventory (PSQI). SAS score and PSQI scores were co-related. Hierarchical regression analyses were conducted to identify the variables independently associated with level of sleep quality.

Results: Out of 240 subjects 117 (48.75%) were poor sleepers & 123 (51.25%) were good sleepers according to PSQI global sleep score. According to SAS score 123 (51.2%) were low users and 117 (48.75%) were high users of Smart phone. The mean (SD) PSQI global score was 4.8 (2.49) and mean (SD) SAS score was 102.93 (22.13). There was positive correlation between SAS score & PSQI score (r=0.343, p<0.001). Gender (β=0.141, p=0.021) & SAS score (β=0.292, p<0.001) were the significant predictors of global PSQI score.

Conclusions: This study concludes that in medical students smartphone addiction affects sleep quality significantly and males are particularly more at risk of having poor sleep quality due to excessive smartphone use.

Keywords: Smart phone addiction, Smartphone use, Sleep quality

INTRODUCTION

A smart phone is a mobile phone having advanced functions along with basic features of making and receiving calls and text messages. A modern smartphone can perform many functions of a computer, having a touchscreen color display, Internet access and a mobile operating system capable of running third-party software components called "*apps*".[1,2] Smartphones are a popular technological device, have increasingly become a major part of our lives due to their numerous benefits, such as easy accessibility to information, social connectivity, workplace applications, convenience, mobility, size, and so forth.[1]

Significant increase in Smartphone use and their capabilities allow evertone to access the internet, communicate, and entertain themselves anywhere and anytime.[3] Just as individuals can become addicted to various substances such as alcohol or drugs, they can also suffer from behavioral addictions where no physical substance abuse is in question, such as addiction to games, computers or the internet and the booming use of smartphones and the fact that these phones encompass

many features have raised the issue of smartphone addiction.[4]

Fifth-Edition of Diagnostic and Statistical Manual of Mental Disorders (DSM-5) has officially recognized the first behavioral addiction disorder (gambling disorder) as a substance-related and addictive disorder and smartphone addiction has several similar aspects to DSM 5 substance related disorders, which includes compulsive behavior, functional impairment, withdrawal and tolerance.[1,5]

Though there are lots of benefits of a smartphone if properly utilized like connectivity, increased productivity, availability of information, portability, smartphone overuse or addiction may lead to negative health consequences like neck pain, accidents, depression and sleep disturbances.[5]

Various theories have been proposed to explain the mechanism of sleep disturbance due to excessive use of electronic media devices like smartphones - interference with sleep through increased psychophysiological arousal, through bright light exposure which may delay the circadian rhythm, exposure to electromagnetic radiations and physical discomfort caused by prolonged media use.[6]

Restoring sleep is strongly associated with a better physical, cognitive, and psychological well-being not only in adults but also in children and adolescents.[7] Episodic memories are gradually assimilated into long-term memory and this process is strongly influenced by sleep & existing memories are spontaneously reactivated and strengthened in the brain during rest periods.[8,9] Sleep problems and sleep deprivation lead to poor academic performance and excessive day time sleepiness in college students.[10,11]

Since medical students are required to be alert & attentive during learning period so that they acquire professional level knowledge & skills of patient care, medical students who already have lots of academic burden and sleep problems due to other factors, smartphone overuse/addiction if present may further complicate the things and may lead to significant stress & mental health problems.

The aim of this study is to investigate the prevalence of the addictive phenomenon related to smartphone use among undergraduate students in KIMS, Hubballi and its effects on sleep quality.

The objectives of the present study are to study the smartphone usage and degree of smartphone addiction among medical students, to assess the sleep quality among medical students and to evaluate the effect of smartphone usage on sleep quality among medical students.

METHODS

This is a cross sectional study done on undergraduate medical students of KIMS, Hubballi, during April-May 2017. The study was approved by the Institutional Ethical committee. Taking standard deviation of SAS score of 23.46 based on the previous studies, minimum sample size required to estimate the mean SAS score with 95% confidence and within 3 points of the true value is 235. It was calculated using the formula $n=(Z_{1-\alpha/2})^2 \; \delta^2/d^2$ where $Z_{1-\alpha/2}$ is Z value for 95% confidence, δ is Standard deviation of SAS score , d is absolute precision. A final sample of 240 randomly selected medical students was included in the study.

Tools used

- Semi-structured proforma that included socio demographic profile and smartphone usage characteristics of participants.
- Smartphone addiction scale (SAS) consists of 6 factors and 33 items with a six-point Likert scale and a total score ranging from 33 to 198.[12] Higher scores indicate more severe addictions. SAS is a relatively valid and reliable scale with Cronbach's alpha of 0.967.
- Pittsburgh sleep quality questionnaire consists of seven component (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, daytime dysfunction) scores from nineteen items.[13] The sum of component scores gives a global score ranging from 0 to 21. Higher scores indicates worse sleep quality. Subjects who got PSQI global score of 5 or less were classified as '*good sleepers*', and those who got more than 5 as '*poor sleepers*'. The PSQI has internal consistency and reliability coefficient (Cronbach's alpha) of 0.83.

The purpose of this research was explained to the participants and the consent was obtained. Data was collected using above mentioned instruments maintaining confidentiality.

Statistical analysis

Data was collected and entered in Microsoft® Excel, it was doubly checked for any errors and data were analysed using R statistical software.[14] Categorical data was summarized as proportion/percentage and numerical data was summarized as mean and standard deviation. Chi square test was used for comparing sleep quality among participants based on demographic characteristics. Independent t test was used to analyze continuous variables. Pearson product moment correlation coefficient was used for assessing the correlation between SAS score and PSQI score. Hierarchical regression analysis was conducted to identify the variables independently associated with sleep quality. The median of the SAS score was calculated to be 103. Those having scores

lesser than or equal to 103 were considered as low users and those having scores greater than 103 as high users for the analysis. P value less than 0.05 was considered significant for all the tests of significance.

RESULTS

Socio-demographic characteristics of subjects

The mean age of subjects was 19.9 years, and there were 142 (59.2%) males & 98 (40.8%) females. 40.8 % of participants were in 1st year, 19.6 % in 2nd year, 27.1 % in 3rd year and 12.5 % in 4th year. In regards to religion 88.3 % students were Hindus, 6.3% Muslims, 3.3% Christians and 2.1% from other religions (Table 1).

Smartphone use and sleep quality

37% of the subjects indicated that they have been using a smartphone for the past 1 to 3 years, 32.5% for less than one year and 30 % for more than 3 years. Though students make use of different functionalities of smartphone including different types of app(s) depending on the need, we categorized the subjects based on the six categories of app(s)/functions of a smartphone which were most preferred or they spent most of the time using on a smartphone. Smartphone was primarily used for social networking by 74.2% of the subjects, for playing games by 9.2 % and academic, scientific and educational related apps/functions were more preferred by 7.1% of the subjects. Smartphone was used in relation to News/current affairs in 3.3%, and for other tasks by 5% of the subjects. Subject were asked about the usual time to start using smartphone after waking up in the absence of any compulsion like answering or replying an important call or a message, 30% told that they start using smartphone immediately after getting up from the bed i.e. less than 5 mins, 30.4% from 5 to 30 mins and 39.6% start using more than 30 mins after waking up. Low users of smartphone were 53.75% and high users were 46.25 % as determined using SAS score. 48.75 % were poor sleepers and 51.25 % were good sleepers according to PSQI global sleep score (Table 2).

Table 1: Socio demographic characteristics of the study sample.

Variables	Groups	n (%)
Age group (in years)	18-19	103 (42.9)
	20-21	97 (40.4)
	22-24	40 (16.7)
	Total	240 (100)
Gender	Male	142 (59.2)
	Female	98 (40.8)
	Total	240 (100)
Religion	Hindu	212 (88.3)
	Muslim	15 (6.3)
	Christian	8 (3.3)
	Others	5 (2.1)
	Total	240 (100)
Year of study	I	98 (40.8)
	II	47 (19.6)
	III	65 (27.1)
	IV	30 (12.5)
	Total	240 (100)

Table 2: Smartphone use characteristics and sleep quality in the study sample.

Variables	Groups	n (%)
Duration of smartphone use (in years)	<1	78 (32.5)
	1-3	89 (37.1)
	>3	73 (30.4)
	Total	240 (100)
Most commonly used app	Social networking	178 (74.2)
	Academic/scientific/education	17 (7.1)
	Games	22 (9.2)
	News/current affairs	8 (3.3)
	Others	15 (6.3)
	Total	240 (100)

Variables	Groups	n (%)
Time to start using smartphone after waking up (in minutes)	<5	72 (30)
	5-30	73 (30.4)
	>30	95 (39.6)
	Total	240 (100)
Smartphone use (Based on SAS score)	Low user	129 (53.75)
	High user	111 (46.25)
	Total	240 (100)
Sleep quality (Based on PSQI score)	Poor	117(48.75)
	Good	123(51.25)
	Total	240(100)

Table 3: Descriptive statistics for smartphone addiction scale scores.

Domains	Mean	SD	Percentiles		
			25	50	75
Daily life disturbance	16.55	5.18	13	17	20
Positive anticipation	25.25	6.89	21	25	30
Withdrawal	16.23	5.55	12	16	20
Cyberspace oriented relation	19.82	6.36	15	19	24
Overuse	14.34	4.61	11	15	18
Tolerance	10.75	3.95	8	11	14
Overall	102.93	22.13	86	103	118

Table 4: Descriptive statistics for PSQI scores.

Domains	Mean	SD	Percentiles		
			25	50	75
Sleep quality	0.76	0.75	0	1	1
Sleep latency	0.83	0.77	0	1	1
Sleep duration	0.95	0.80	0	1	1
Sleep efficiency	0.43	0.69	0	0	1
Sleep disturbance	0.91	0.70	0	1	1
Sleep medication	0.10	0.39	0	0	0
Sleep dysfunction	0.82	0.67	0	1	1
Global score	4.80	2.49	3	4	6

Table 5: Distribution of study subjects according to socio demographic variables with sleep quality.

Variables	Groups	Sleep quality			Chi square test
		Poor	Good	Total	
Gender	Male	78 (66.67)	64 (52.03)	142 (59.17)	
	Female	39 (33.33)	59 (47.97)	98 (40.83)	P=0.021*
	Total	117 (100)	123 (100)	240 (100)	
Age (in years)	18-19	43 (36.75)	60 (48.78)	103 (42.92)	
	20-21	52 (44.44)	45 (36.59)	97 (40.42)	
	22-24	22 (18.8)	18 (14.63)	40 (16.67)	P=0.168
	Total	117 (100)	123 (100)	240 (100)	
Year of study	I	46 (39.32)	52 (42.28)	98 (40.83)	
	II	20 (17.09)	27 (21.95)	47 (19.58)	
	III	34 (29.06)	31 (25.2)	65 (27.08)	P=0.586
	IV	17 (14.53)	13 (10.57)	30 (12.5)	
	Total	117 (100)	123 (100)	240 (100)	

* Significant

Overall mean score on smartphone addiction scale was found to be 102.93. Standard deviation was 22.93, with minimum score of 33 and maximum score of 166 (Table 3). The Cronbach's alpha in our study was 0.871.

The mean for global PSQI score was 4.80, standard deviation was 2.49 with minimum score of 0 and maximum score of 14 (Table 4).

Males constituted 67% of poor sleepers and 52% of good sleepers, whereas females were 33% of poor sleepers and 48% of good sleepers. This difference observed was statistically significant. There was no statistically

significant association between age group, year of study with sleep quality (Table 5).

There was significant association between sleep quality and time of initiation of smartphone use, percent of subjects classified as good sleepers increased with increasing time to initiate smartphone use after waking up. Low smartphone user constituted 67% of good sleepers and 39% of poor sleepers, whereas among high users 33% were good sleepers and 61% poor sleepers. This difference was statistically significant. There was no significant association of duration since starting the use of smartphone and type of app/function used with sleep quality (Table 6).

Table 6: Distribution of study subjects according to smart phone usage variables with sleep quality.

Variables	Groups	Sleep quality			Chi square test
		Poor	Good	Total	
Duration of smart phone use (in years)	<1	35 (29.91)	43 (34.96)	78 (32.5)	p=0.444
	1-3	42 (35.9)	47 (38.21)	89 (37.08)	
	>3	40 (34.19)	33 (26.83)	73 (30.42)	
	Total	117 (100)	123 (100)	240 (100)	
Most often used App(s)/ function used	Social network	89 (76.07)	89 (72.36)	178 (74.17)	p=0.267
	Academic/educ	8 (6.84)	9 (7.32)	17 (7.08)	
	Games	10 (8.55)	12 (9.76)	22 (9.17)	
	News/current affairs	2 (1.71)	6 (4.88)	8 (3.33)	
	Others	8 (6.84)	7 (5.69)	15 (6.25)	
	Total	117 (100)	123 (100)	240 (100)	
Smartphone use initiation after wake up (in years)	<5	45 (38.46)	27 (21.95)	72 (30)	p=0.018*
	5-30	33 (28.21)	40 (32.52)	73 (30.42)	
	>30	39 (33.33)	56 (45.53)	95 (39.58)	
	Total	117 (100)	123 (100)	240 (100)	
Smartphone use (SAS score)	Low user	46 (39.32)	83 (67.48)	129 (53.75)	p<0.001*
	High user	71 (60.68)	40 (32.52)	111 (46.25)	
	Total	117 (100)	123 (100)	240 (100)	

*Significant

Figure 1: Mean SAS score in two groups.

Table 7: Correlation between SAS score and PSQI score for different variables.

| Variables	Groups	N	R	R^2	P value
Age (in years)	18-19	103	0.230	0.053	0.020 *
	20-21	97	0.469	0.220	<0.001*
	22-24	40	0.313	0.098	0.049*
Gender	Male	142	0.363	0.132	<0.001*
	Female	98	0.274	0.075	0.006*
Year	I	98	0.194	0.038	0.056
	II	47	0.461	0.213	0.001*
	III	65	0.492	0.242	<0.001*
	IV	30	0.322	0.104	0.083
Duration Of use (in years)	<1	78	0.303	0.092	0.007 *
	1-3	89	0.175	0.031	0.101
	>3	73	0.505	0.255	<0.001 *
Commonly Used app	Social networking	178	0.339	0.115	<0.001*
	Academic/scientific/education	17	0.391	0.153	0.120
	Games	22	0.169	0.029	0.451
	News/current affairs	8	0.761	0.579	0.028 *
	Others	15	0.524	0.275	0.045
Smartphone use initiation after wake up (in mins)	<5	72	0.320	0.102	0.006 *
	5-30	73	0.294	0.086	0.012 *
	>30	95	0.327	0.107	0.001 *
Overall		240	0.343	0.117	<0.001 *

*Significant
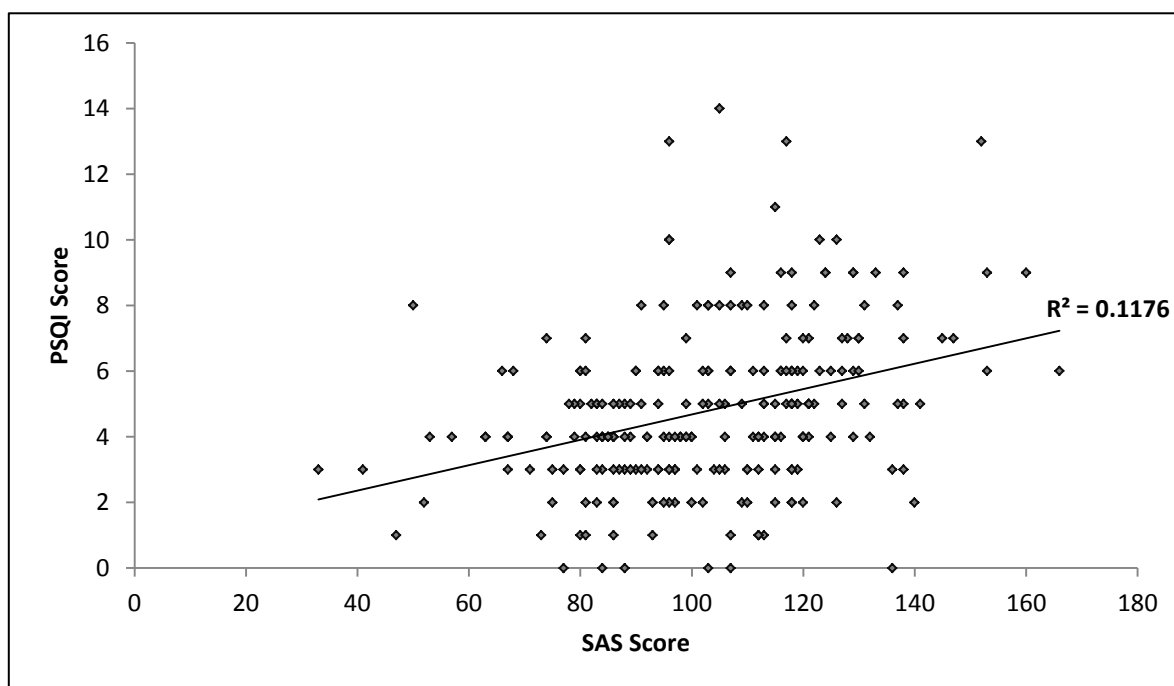
Figure 2: Scatterplot for SAS score and PSQI score.

The mean (SD) SAS among poor sleepers was 111.15 (20.91) and among good sleepers was 95.10 (20.41), the difference was statistically significant (df=238, t=6.02, p<0.001) (Figure 1).

Co-relation analysis showed that there is positive co-relation (r=0.343) between sleep score and SAS score, which is statistically significant (P<0.001). The correlation was positive and statistically significant in most of the sub groups (Table 7) (Figure 2).

A hierarchical multiple regression was run to determine if the addition of total SAS score, time to initiate smartphone use after wake up and time since starting the

use of smartphone improved the prediction of Global sleep score over and above age and gender alone. The full model of gender (0= Female, 1= Male), age, time to initiate smartphone use after wake up, time since starting the use of smartphone and total SAS score to predict Global sleep score (Model 3) was statistically significant, r^2=0.157, F=8.725 p<0.0005; adjusted r^2=0.139. The

addition of time to initiate smartphone use after wake up & total usage duration to the prediction of Global sleep score (Model 2) led to a statistically significant increase in r^2 of 0.045, F=5.778, p=0.001. The addition of total SAS score to the prediction of Global Sleep score (Model 3) also led to a statistically significant increase in r^2 of 0.077, F=21.457, p<0.001 (Table 8).

Table 8: Hierarchical regression analysis of independent variables related sleep quality.

| Variables | Global sleep score | | | | | |
| | Model 1 | | Model 2 | | Model 3 | |
	B	Beta	B	Beta	B	Beta
Age	0.099	0.057	-0.025	-0.014	-0.003	-0.002
Gender[#]	0.919**	0.181	0.826*	0.163	0.716*	0.141
Time to initiate use			-0.568**	-0.189	-0.323	-0.108
Usage duration			0.379	0.121	0.300	0.096
SAS Score					0.033**	0.292
R	0.186		0.283		0.396	
R²	0.035		0.080		0.157	
Adjuated R²	0.026		0.064		0.139	
F	4.249*		5.099**		8.725**	
ΔR²	0.035		0.045		0.077	
ΔF	4.249*		5.778**		21.457**	

*p<0.05, **p<0.001, # Gender (0= Female, 1=Male).

DISCUSSION

This study was conducted to assess the smartphone usage and its impact on sleep quality in medical undergraduate students of KIMS, Hubballi. This study shows that Smartphone addiction was associated with poor sleep quality. This is one of the few studies conducted among medical students relating to smart phone addiction and sleep quality. Our study found that 46% of medical students were high users of smartphone based on SAS score and 57% were low users. In a study conducted among adolescents 54 % were low users and the mean SAS score was 85.66 and in our study it was 102.93.[15] A study by Kwon, Lee et al showed that the SAS mean score was 110.02, in a study by Demirci et al reported in 2014 the SAS mean score was 75.76 and in other study in 2015 it was 75.68.[4,12,16] The Mean SAS score was significantly higher among poor sleepers than compared to good sleepers, suggesting relation between smartphone use and sleep quality. In our study 117 (49%) were having poor sleep quality according to PSQI scale, this was similar to other studies conducted on medical students in Iran which showed 40.6% prevalence of poor sleepers, 38.9% in Brazil, 77% in Pakistan and in a study conducted on non-medical college students it was about 60%.[17-20]

There was association between gender and sleep quality on univariate analysis with more boys among poor sleepers than among good sleepers, but on multivariate analysis it was not significant. In a study conducted by Ghoreishi et al on university medical students, out of total poor sleepers, 44.8% were male and 38% were female

though the difference was not significant.[17] In a study by Soni et al among adolescents, the mean (SD) global PSQI score was 10.75 (3.49), in a study by Waqas et al among medical students it was 8.1 (3.12) and in the present study it was 4.8 (2.49).[15,19] Those subjects who had high scores on SAS scale also had higher scores on PSQI scales, indicating high levels of poor quality of sleep among high users of smartphone. Positive and significant correlation was found between the SAS score and global PSQI score in a study conducted in Turkey with correlation coefficient (r) of 0.156 and in the present study it was 0.343.[16] Correlation analysis showed positive correlation in most of the subgroups of different variables. PSQI global score was significantly higher (5.5) in High smartphone user group than compared to low users (4.19). In a study among nursing students by Ahn and Kim along with smartphone overuse stress was also a factor significantly influencing quality of sleep, with an explanatory power of 21.1%.[21] In our study on multivariate logistic regression only high SAS score was significantly associated with poor sleep quality, by hierarchical linear regression our final model showed gender and smartphone use (SAS) were significant predictors of Global PSQI score. Male students had high PSQI score (poor sleep quality) than females and Students with high SAS score (smartphone addiction) had high PSQI global scores. The model had 14 % explanatory power but stress was not included in our study. Lemola et al reported that smartphone ownership was related to late bedtimes in adolescents but it was unrelated to sleep disturbance.[22]

Various studies have reported that the addiction or overuse of electronic devices, Internet and smartphone

are similar as for as their effect on sleep is concerned as they lead to exposure to either bright light of the screens or electromagnetic radiations or both.

Loughran et al reported that mobile phone exposure prior to sleep may modify the sleep electroencephalogram.[23] Various studies have shown that melatonin production is decreased on exposure to electromagnetic fields especially in the evening and hypothesis that decreased melatonin is the cause for impaired sleep quality has been suggested.[24]

In a study by Hysing et al both daytime and bedtime use of electronic devices led to an increased risk of short sleep duration, long sleep onset latency and sleep deficiency.[6]

One more smartphone use variable we studied was time to initiate smartphone use after waking up from bed which showed association with sleep quality on univariate analysis but not on multivariate analysis. Checking the smartphone immediately after waking up or repeatedly can both be a cause or an effect of smartphone addiction. A study by Oulasvirta et al reported that smartphone use is associated with a checking habit which is a brief, repetitive inspection of dynamic content quickly accessible on the device and this checking habit occasionally spur users to do other things with the device and are reinforced by informational rewards which may increase usage overall.[25]

Smartphone use has been rising and has improved the productivity in many ways and particularly in the medical profession with the availability of so many useful apps. A study showed that in 24 hours, apps for disease diagnosis/management and drug reference app were used for between 1–30 minutes by students and 1–20 minutes by doctors who favored using clinical score/calculator apps.[26] Lanaj et al reported that smartphone use for work at night increased depletion the next morning via its effects on sleep, morning depletion in turn diminished daily work engagement which was incremental to the effects of other electronic devices like computer, TV tablet etc.[27]

Apart from its effect on sleep, smartphone addiction has effect on physical and psychological health; other than smartphone addiction, sleep quality itself has many determinants among students in general and among medical students in particular.

Limitations

This study had some limitations, stress due to academic burden which is very common in medical students as a determinant of sleep quality was not studied. This was a cross sectional study involving 240 medical students, longitudinal studies on a larger sample with different student groups will be required to generalize the results. Quantification of sleep quality and smartphone use was based on self-rating; objective measuring tools will give precise results.

CONCLUSION

This study showed that that medical students especially males who are addicted to smartphone have poor quality sleep. Medical students, who have to develop their skill and knowledge to be competent professionals, should use smartphone appropriately and be cautious about negative effect of smartphone addiction on sleep as well as physical and psychological health.

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