

Original Article

## The Correlation between Cell Phone Use and Sleep Quality in Medical Students

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### Abstract

#### Introduction

The negative health effects of electromagnetic radiation and psychological dependence are among the major consequences of widespread cell phone use in the general population, especially among adolescents. In this study, the relationship between cell phone use and sleep quality parameters was evaluated.

#### Materials and Methods

The study sample consisted of 820 students (305 males and 515 females), recruited from Arak University of Medical Sciences, Arak, Iran. The participants completed Pittsburgh Sleep Quality Index (PSQI) and Cell-phone Overuse Scale (COS); the validity of these questionnaires had been previously confirmed in the Iranian population. Information on demographic characteristics and variables associated with cell phone exposure, such as the frequency and duration of phone calls and number of messages was collected in a separate questionnaire.

#### Results

Data analysis showed that cell phone overuse was significantly correlated with sleep quality and its components. Moreover, the results indicated that the global PSQI score and some sleep components were significantly correlated with several variables related to cell phone use. Based on the findings, the mean PSQI score was significantly different among heavy and light cell phone users ( $P < 0.01$ ). Moreover, among heavy cell phone users, females had a higher global PSQI score, compared to males ( $P < 0.01$ ).

#### Conclusion

According to the literature and the present study, services provided by modern cell phones, along with the extensive use of these devices, could be considered as potential threats to public health, especially adolescents' sleep quality. In order to reach a definitive conclusion, further systematic and laboratory studies are required.

**Keywords:** Cell phone, Sleep quality, Medical students

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## 1. Introduction

Cell phones, as one of the most advanced technologies in today's world, have provided various services such as text messaging, multimedia services, information exchange, audio/video recording and playback, calendar, entertainment and gaming, banking services, business applications, and Internet access for the users. Most of the provided services by cell phones involve data transfer by sending and receiving electromagnetic waves. Therefore, concerns are growing regarding the possible adverse effects of cell phone use for the public, even if an individual does not directly use the device [1]. Evidence suggests that use of cell phones or exposure to cell phone radiation can cause clinical symptoms such as headache, sleep disturbance, and dizziness [2-5].

In European countries, occurrence of headache, fatigue, and other symptoms has been reported to be associated with the use of cell phones. Headaches and burning sensations around the ears and facial skin are the most commonly reported symptoms [6]. Some studies have shown that long-term cell phone use can cause anatomical pain (i.e., neck, shoulder, and low back pain) [7] and hearing or vision impairments [8].

Some scientific studies showed exposure to microwave radiation can cause genetic changes in primary cultures of neurons and astrocytes [9] and in some cases, increase oxidative stress in corneal and lens tissues [10]. Besides the emphasis placed on the harmful effects of cell phone radiation by medical researchers, extensive psychological and social research has been performed on this subject [11]. These findings have revealed that low self-esteem is related to problems associated with cell phone use [12].

Previous findings have shown that people with low social skills are more likely to use their cell phones to play games on their devices. These findings emphasize the relationship between personality and problematic cell phone use or overuse [13]. In fact, more extroverted and neurotic individuals spend more time on making phone calls, whereas disagreeable spend more time on text messaging, compared to others.

Additionally, disagreeable individuals and those with low self-esteem spend more time on sending messages. In previous studies on addictive tendencies related to communication technologies, neurotic individuals reported stronger cell phone addictive tendencies, while more disagreeable individuals and those with lower self-esteem had stronger instant messaging addictive tendencies, compared to others [14].

According to previous research, a substantial number of female medical students use modern cell phones, with possible health hazards; in fact, the pattern of use can lead to risky behaviors among users. The most significant negative impacts of cell phone use include memory impairments and disturbances in sleep and concentration, which may disrupt the user's academic training [15]. The aim of this study was to investigate the correlation between cell phone use and sleep quality among students of Arak University of Medical Sciences, Arak, Iran.

## 2. Materials and Methods

### 2.1. Sampling

The present study was conducted in the Department of Medical Physics, Collage of Paramedicine, Arak University of Medical Sciences during March-June, 2014. After obtaining an approval from the Ethics and Scientific Committee, 1000 questionnaires were distributed among the participants, 832 of which were handed to the researcher. Among the delivered questionnaires, 12 were blank or sketchy, while 820 were fully completed (by 305 males and 515 females). Moreover, the study objectives were explained to the participants by our colleagues.

### 2.2. Demographic information

Information on cell phone exposure and demographic characteristics was collected, using the baseline questionnaire. The collected variables included age, gender, history of cell phone possession, average frequency of phone calls made and received per day, average number of text messages sent and received per day, distance between the cell phone and person during sleep time, and duration of Internet connection by the cell phone.

### 2.3. The standard questionnaires

**Cell-Phone Overuse Scale (COS):** To evaluate cell phone overuse by the participants, COS was used. This scale was based on seven out of ten pathological gambling criteria in the Diagnostic and Statistical Manual of Mental Disorders [16]. COS is a 23-item scale, rated on a six-point Likert scale, with high scores reflecting cell phone overuse (1= never, 2= almost never, 3= sometimes, 4=often, 5=almost always, and 6= always).

The consistency of the original version of COS was 0.87 in the Spanish population. Its consistency was estimated at 0.9 in the translated Farsi version, applied in the Iranian population [17]. Similar to the original questionnaire, scores below the 25th percentile and over 75<sup>th</sup> percentile were considered as low and high frequency of cell phone use, respectively.

**Pittsburgh Sleep Quality Index (PSQI):** PSQI consists of 19 self-rated items, which assess sleep quality and sleep disturbance over the past month. In this scale, seven domains including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction are evaluated. In the present study, the Farsi version of PSQI was employed [18].

The reliability and validity of PSQI have been previously determined in the Iranian population [19]. The internal consistency of the Farsi version of PSQI was determined as satisfactory (Cronbach's alpha= 0.73). In this study, in consistence with the literature, higher scores indicated lower sleep quality. A global score  $\geq 5$  would indicate poor sleep quality over the past month [20].

### 2.4. Statistical analysis

After data collection and classification, in addition to descriptive tests, data were evaluated, using statistical methods. T-test, ANOVA test, and Pearson's correlation coefficient test were applied for statistical analysis, using SPSS version 20.

## 3. Results

The mean age of male and female participants was  $20.24 \pm 2.21$  and  $20.70 \pm 2.7$  years,

respectively. Based on the findings, male participants had a longer history of cell phone possession ( $6.31 \pm 2.12$  years), compared to females ( $5.16 \pm 1.70$  years). As the findings revealed, 72.7% of men and 79.5% of women put their cell phones at a distance less than 30 cm from their head or body during sleep time.

The results showed that 61.3% of males and 67.4% of females were connected to the Internet by their cell phones for more than one hour a day. Good sleepers accounted for 60.3% of the subjects (PSQI score  $< 5$ ), while 39.7% of the participants were poor sleepers (PSQI score  $> 5$ ). PSQI score  $> 5$  was reported in 56.7% of males versus 62.5% of females; the difference was statistically significant ( $P=0.001$ ).

As presented in Table 2, history of cell phone possession was not significantly correlated with the global PSQI score or some components of the scale. Although there was a significant correlation between the frequency of phone calls (made and received) and some components of PSQI, the global PSQI score was not significantly correlated with this variable.

According to the findings, the global PSQI score showed a positive significant correlation with the duration of each phone call and PSQI components, except for daytime dysfunction. With the exemption of sleep disturbance, other components of PSQI and the global PSQI score had a positive significant correlation with the frequency of text messaging (including text messages exchanged by cell phone operators, while excluding social network messaging).

Based on the results, distance of the cell phone from the head had a negative correlation with the global PSQI score and some of the scale components during night sleep. Moreover, among cell phone-related variables, spending time on the Internet via cell phone had a more significant positive correlation with global PSQI score, based on Spearman's correlation test ( $r=0.262$ ;  $P<0.001$ ).

The correlation between PSQI and COS scores was positive for all the participants ( $r_s=0.354$ ;  $P<0.001$ ); however, this correlation was more significant among females than males. In addition, all components of PSQI, except sleep

## The Effect of Cell Phone Use on Sleep Quality

efficiency, had a more significant positive correlation with COS components in females compared to males. As presented in Table 3, a significant difference was observed between light and heavy cell phone users in terms of the global PSQI score and all PSQI components. Based on COS scoring (25<sup>th</sup> and 75<sup>th</sup> percentiles indicating light and heavy users, respectively), 218 participants were classified as heavy cell phone users, while 223 were light users. Statistical analysis showed no significant difference between male and female light cell

phone users in terms of the global PSQI score and its components, except for sleep latency and sleep quality ( $P < 0.05$ ) (Table 4).

Among heavy cell phone users, a significant difference was observed between males and females regarding global PSQI score; although poor sleep was reported in both genders, females obtained higher scores than males. In this group, a significance difference was observed between all the components of PSQI and gender ( $P < 0.05$ ), except for the use of sleep medication ( $P > 0.05$ ).

Table 1. Cell phone variables among male and female participants

Cell phone variables	Male		Female	
	N=305		N=515	
	Freq.	%	Freq.	%
<b>History of cell phone possession (years)</b>				
1-2	13	4.3	27	5.2
2-4	34	11.1	145	28.2
4-6	133	43.6	228	44.3
6-8	87	28.5	115	22.3
8-11	38	12.5	0	0
<b>Frequency of phone calls per day (made and received)</b>				
1-3	87	28.5	107	20.8
4-6	131	43	352	68.3
7-10	41	13.4	26	5
>10	46	15.1	30	5.8
<b>Mean duration of each phone call (min)</b>				
<5	208	68.2	273	53
5-10	41	13.4	127	24.7
10-15	15	4.9	44	8.5
15-20	16	5.2	45	8.7
>20	25	8.2	26	5
<b>Number of text messages per day</b>				
1-6	44	14.4	103	20
7-12	72	23.6	122	23.7
13-20	56	18.4	52	10.1
>20	133	43.6	238	46.2
<b>Connection to the Internet via cell phones (min)</b>				
None	47	15.4	52	10.1
0-15	7	2.3	40	7.8
15-30	26	8.5	27	5.2
30-45	18	5.9	30	5.8
45-60	21	6.6	19	3.7
>60	187	61.3	347	67.4
<b>Distance of cell phone from the head in the bed (cm)</b>				
5-10	44	14.4	99	19.2
10-20	102	33.4	157	30.4
20-30	76	24.9	153	29.7
>30	38	12.5	42	8.1
Off	45	14.8	64	12.4

Table 2. Correlation between PSQI scores and cell phone-related variables

	History of cell phone possession	Frequency of phone calls (made and received)	Mean duration of each call	Number of text messages (made and received)	Distance of cell phone from the head in the bed	Spending time on the Internet via cell phone	COS		
							Male	Female	Total
PSQI	-0.053	0.058	0.176**	0.218**	-0.232**	0.262**	0.25**	0.428**	0.354**
Sleep quality	0.049	0.113**	0.126**	0.22**	-0.052	0.159**	0.039	0.418**	0.284**
Sleep latency	0.003	-0.075*	0.21**	0.169**	-0.205**	0.088*	0.144*	0.276**	0.214**
Sleep duration	-0.052	0.103**	0.141**	0.125**	-0.177**	0.029**	0.262**	0.203**	0.217**
Sleep efficiency	0.031	0.061	0.070*	0.139**	-0.018	0.198**	-0.036	0.286**	0.168**
Sleep disturbance	-0.063	-0.137**	0.124**	0.047	-0.125**	0.007	0.201**	0.217**	0.204**
Use of sleep medication	-0.023	0.052	0.087*	0.123**	-0.051	0.051	0.189**	0.284**	0.250**
Daytime dysfunction	-0.046	-0.007	0.025	0.087*	-0.016	0.11**	0.132*	0.323**	0.246**

\*Significant correlation at 0.05

\*\*Significant correlation at 0.01

Table 3. Comparison between light and heavy cell phone users in terms of the global PSQI score and its components

	Type of use	Mean	SD	P-value
PSQI	Light cell phone users	5.28	0.188	<0.01
	Heavy cell phone users	8.53	2.77	
Sleep quality	Light cell phone users	0.99	0.70	
	Heavy cell phone users	1.41	0.67	
Sleep latency	Light cell phone users	0.95	0.99	
	Heavy cell phone users	1.51	0.96	
Sleep duration	Light cell phone users	1.21	0.76	
	Heavy cell phone users	1.76	1.28	
Sleep efficiency	Light cell phone users	0.57	0.45	
	Heavy cell phone users	0.18	0.92	
Sleep disturbance	Light cell phone users	0.96	0.44	
	Heavy cell phone users	1.33	0.67	
Use of sleep medication	Light cell phone users	0.00	0.00	
	Heavy cell phone users	0.38	0.72	
Daytime dysfunction	Light cell phone users	1.00	0.69	
	Heavy cell phone users	1.54	0.94	

## The Effect of Cell Phone Use on Sleep Quality

Table 4. Differences between light and heavy cell phone users (male and female) regarding PSQI score

	Light cell phone users		P-value	Heavy cell phone users		P-value
	Male (N=76)	Female (N=141)		Male (N=102)	Female (N=116)	
PSQI	5.13±1.85	5.36±2.4	>0.05	7.5±3.2	9.4±3.9	<0.01
Sleep quality	1.25±0.71	0.86±0.66	<0.05	1.21±0.51	1.59±0.74	<0.05
Sleep latency	0.65±0.64	1.10±0.9	<0.05	1.14±0.83	1.84±0.94	<0.01
Sleep duration	1.20±0.76	1.30±0.75	>0.05	1.95±1.57	1.60±0.94	<0.05
Sleep efficiency	0.36±0.15	0.49±0.20	>0.05	0.89±0.40	0.93±0.71	<0.05
Sleep disturbance	0.90±0.49	0.99±0.41	>0.05	1.19±0.50	1.45±0.77	<0.05
Use of sleep medication	0.00±0.00	0.00±0.00	>0.05	0.76±0.37	0.68±0.38	>0.05
Daytime dysfunction	1.07±0.64	0.96±0.71	>0.05	1.20±0.72	1.83±1.01	<0.01

### 4. Discussion

Cell phone use has dramatically increased in today's world. Since electromagnetic waves are used for data transmission by cell phones, some concerns have been raised about their negative impacts on public health. The effect of cell phone use on sleep quality is among these concerns, which can be evaluated by laboratory methods, epidemiological surveys, and standard questionnaires.

In this study, by using two standard questionnaires (COS and PSQI), the relationship between cell phone overuse and sleep quality was assessed among medical students in Arak, Iran. According to some previous studies, increased incidence of insomnia is attributed to increased emotional reactivity [21, 22]. Cell phones by offering a wide range of services, such as text messaging, multimedia messaging services, E-mail, Internet access, business applications, gaming, and photography, are regarded as risk factors for overexcitement or physiological arousal among users [23].

In previous studies, SMS users were more likely to be neurotic, depressed, or anxious, indicating the possibility of disturbance in

sleep quality [13, 24]. The results of the present study also showed that people who receive and send more text messages have lower sleep quality, compared to others. In this regard, in a study in Japan, sleep disturbance among adolescents could be associated with cell phone use for making phone calls and sending text messages after turning off the lights [25].

According to some previous studies, sleep quality declines with the growing use of social networks. In fact, for engagement in social networks, people are sometimes forced to reduce their hours of sleep to stay online. In a recent study comparing Internet addiction in men and women's in Korean society, it was found significant gender differences of addictive Internet use in its associated individual- and school-level factors [26].

Dependence of users on their cell phones could be related to factors such as online gaming, free TV streaming services, social networking, and GPS services [27]. The present study also revealed that spending time on the Internet via cell phones had a positive correlation with the global PSQI score and some of the scale components. According to

the demographic data, Viber, WhatsApp, and Instagram were among popular apps, which were commonly used by the participants.

Based on previous studies, cell phone overuse could lead to somatic complaints, insomnia, social dysfunction, anxiety, and depression [28, 29]. In the present study, a significant positive correlation was found between PSQI score and cell phone overuse; moreover, a significant difference was detected between males and females. These findings were in agreement with previous studies, which have emphasized on the association between sleep disturbance and frequent cell phone use [30, 31].

Quality of sleep can be affected by different factors such as physical, chemical, and psychophysiological parameters, including electromagnetic radiation. Evidence provided by some studies has shown that exposure to electromagnetic fields (in the range of cell phone frequency) prior to sleep could cause rapid eye movements, sleep latency, and alterations in human's brain activity during sleep [32]. The present study also revealed a significant negative correlation between the distance of cell phone from the head in the bed and global PSQI score. Also, the results demonstrated that sleep latency has a negative correlation with the distance of cell phone from the head in the bed.

Previous research has described an association between sleep disorders and use of electronic devices. In a survey conducted by Van den Bulck, it was revealed that watching television, gaming, and Internet access cause users to go to bed late on weekdays and get up late on weekends. Overall, cell phones have been introduced as a threat to sleep quality and a cause of overexcitement or recurring nightmares [33, 34].

Besides phone calls and text messages, the information exchanged by cell phones can provide great entertainment for users, particularly adolescents; this type of information can lead users to become overexcited, thus causing sleep disorders. The present study confirmed these findings

regarding sleep latency and other PSQI components among heavy cell phone users.

The present results were in line with the findings reported by Arora *et al.*, who concluded that frequent nightmares are associated with cell phone overuse, video gaming, and listening to music. According to their findings, adverse sleep outcomes such as nightmares may be evoked by exposure to violent visual or verbal content before bedtime [35].

Impulsivity is a multifaceted concept, defined as an instinctive act without any forethought or consideration of the consequences. UPPS Impulsive Behavior Scale is one of the tools, which can be used to examine various aspects of an impulsive personality. Four subscales measured by this questionnaire include urgency, (lack of) premeditation, (lack of) perseverance, and sensation seeking [36].

Billieux and colleagues proposed a significant relationship between impulsivity and excessive use of cell phones. In their study, a positive correlation was found between perceived dependence on cell phones and urgency [37]. In addition, lack of perseverance was identified as a predictor of the duration of daily phone calls. Also, a positive correlation was found between perceived dependence on cell phones and lack of perseverance. These findings confirmed the association between frequent use of cell phones and impulsivity.

In the present study, the increase in COS score due to answering questions, such as "Do you use the mobile phone to escape from your problems?" and "Have you ever tried to not use the cell phone and failed?", could be the reason for impulsive behaviors and the related effects, which eventually lead to the overuse of cell phones.

Based on the present research and some previous studies [12, 38], services provided by modern cell phones or cell phone overuse could be considered as potential threats to public health, especially adolescents' sleep quality. Since sleep quality is a multifunctional variable, which can be interfered by various biochemophysical and environmental factors,

further systematic and laboratory studies are required for making a definitive conclusion.

### 5. Conclusion

In parallel with the traditional addictions, the new technologies such as mobile phones with modern hardware and software facilities such as listening to music, viewing the videos, internet connection, the possibility of the search on the cyberspace and activity on the social networks can provide the new addictions. The results of this study suggest that sleep quality and its subscales accordance to Pittsburgh Sleep Quality Index can be

affected by excessive use of mobile phones. Sleep quality is an important clinical structure that prevention of its defects can enhance the quality of life and academic performance for students.

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