Original Article

The Effect of Cell Phone Use in Adolescents on Sleep Qualıty: Central Anatolia Case

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Abstract

Purpose: Poor sleep quality is closely related to lifestyle habits including the use of cell phones. This study is a cross-sectional study conducted to investigate the effects of characteristics of cell phone use in adolescent university students on sleep quality

Methods: The study was conducted with randomly selected 1040 students who continue their undergraduate education at a state university. The data were collected using a survey designed by the researchers drawing on the literature and Pittsburgh Sleep Quality Index (PSQI). The data were analyzed through t test, variance analysis and multiple regression model. $p < 0.05$ was set to define statistical significance.

Results: Average duration of cell phone use was 6.6 ± 2.4 years, and almost all the students in the study stated that they use their phones to keep in contact with their family and friends. The score students received from the PSQI was 7.52 ± 3.21 (Min: 0 - Max: 17), and 70.9% of the students had poor sleep quality. Multiple regression model showed the strongest correlates Sleep quality and between duration of talking on the cell phone at a time, talking on the phone while charging and the place where the cell phone. This model explained 7% of the variance in sleepy quality.

Conclusions: The results of the study revealed that sleep quality of three fourth of the students is poor and characteristics of cell phone use has a negative effect on sleep quality. As these findings suggest, awareness of students must be raised with regard to over-use of cell phones so that possible negative effects can be minimized, and students must be encouraged to take part in educational, cultural, and sports activities, but this needs to be examined further.

Key words: Sleep quality; Cell-Phone; Students, Adolescent Health, Multiple Regresyon

Introduction

Sleep is one of the fundamental requirements to meet the biological, psychological, social, and cultural needs of a person. Sleep is an important part of healthy life, and it is directly related with health and quality of life (Owens, 2014). Regular sleep duration and sleep quality enhance the physical and emotional well-being of the individual. Studies have revealed that insufficient and poor quality sleep affects cognitive functions, general health condition and well-being negatively (Munezawa, Kaneita et al., 2011). In adolescence, daily sleep requirement is between 8.5 and 9.3 hours, while it is higher in adults. During adolescence, when physical growth accelerates, sleep is the fundamental factor in improving physical and academic performance (Owens, 2014; Ergun, Duran, Gultekin & Yanar, 2017). Despite the increasing need for sleep, daily sleep duration decreases due to the factors specific to this period, which brings problems with it. Sleeping late at night and getting up late are sleep characteristics of this period. It has been noted in many recent studies that widespread use

of cell phones has played an important role in the emergence of sleep related problems in adolescents (Munezawa, Kaneita et al., 2011; Tao, Wu et al., 2017; Li, Lepp & Barkley 2015; Durusoy, Hassoy et al., 2017; Leena, Tomi, Arja, 2005). Cell phones, which are the product of developing technology, have become a part of our everyday lives. The use of cell phones has gradually increased among students as they facilitate communication; they are portable, and they offer the opportunity to use the Internet and take photos (Kuyucu, 2017). Previously conducted studies revealed that thanks to these characteristics, 74.8% - 84.0% of adolescents in our country and in the world have been using cell phones (Munezawa, Kaneita et al., 2011; Tao, Wu et al., 2017; Li, Lepp & Barkley, 2015; Massimini & Peterson, 2009). Cell phones lead to health problems as well as facilitating communication and life. Cell phones, which are extremely useful and convenient when used correctly and appropriately, can have serious physiological and psychological negative effects when used unconsciously and excessively. Exposure to radio-frequency electromagnetic frequencies (EMF) has caused public and scientific discussions because of the negative effects of these frequencies on human health both during signal reception and transmission. Many studies have shown that cell phone overuse leads to lack of concentration, weakness, fatigue, increase in blood pressure, headache, eye problems and sleep disorders (Tao, Wu et al., 2017; Li, Lepp & Barkley, 2015; Kuyucu, 2017; White, Buboltz & Igou, 2010; Santini, Seigne et al.,2002). The current study was conducted to investigate the effects of cell phone use on the sleep quality of university students in a rural area in Central Anatolia.

Methods

Participants: The research population is composed of the undergraduate students who were studying at Vocational School of Health, Faculty of Engineering, Faculty of Economy, and Faculty of Arts and Science in a university. The sample of the study, on the other hand, is comprised of 1040 students who were selected through randomly sampling and who gave their consent to participate in the study.

Measures: The data were collected using information from and the Pittsburgh Sleep Quality Index (PSQI).

İnformation From: The survey is composed of a total of 14 questions which were developed

drawing on the literature (Munezawa, Kaneita et al., 2011; Santini, Seigne et al., 2002; Thomee, Harenstam & Hagberg, 2011; Saygılı, Çil Akıncı et al., 2011; Sahin, Ozdemir et al., 2013; Söderqvist, Carlberg, Hardell, 2013). Four questions aimed to collect socio-demographic information from the students, while ten questions were designed to identify the over-use of mobile cell-phone of students.

Pittsburgh Sleep Quality Index (PSQI): The index, which was developed by Buysse et al. (1989), has been used to determine the sleep quality of the students (Buysse, Reynolds & Monk 1989). PSQI is a self report scale consisting of 19 questions, which evaluate the sleep quality and sleep disorder in the past one month. It involves 24 questions, 19 of which are self-report questions and 5 of which are the questions to be answered by the spouse or roommate. 18 questions in the scale are scored. These questions are grouped under seven components, which are Subjective Sleep Quality, Sleep Latency, Sleep Duration, Habitual Sleep Efficiency, Sleep Disturbances, Use of Sleeping Medication, and Daytime Dysfunction. Each component is scored out of 0 to 3. The total score of the seven components gives the total score, which changes between 0 and 21. Sleep quality is evaluated as "good" if the total score is 5 and below. The Turkish reliability and validity study of the scale was conducted by Agargun et al., and internal consistency coefficient of the scale was found to be 0.80 (Agargun, Kara & Anlar,1996). The scale achieved a Cronbach's alpha of 0.83.

Data Analysis: The distribution of the data was evaluated by using skew analyses. Most data were normally distributed. Percentage distributions, t test and variance analysis (in independent groups), and multiple regression analysis were used in data analysis. $p<0.05$ was set to indicate statistical significance. In order to determine the extent to which the Pittsburgh Sleep Quality Index scores were affected, the effect of three variables which were found to be related to sleep quality and cell phone over-use of the students was evaluated through multiple regression analysis. Sleep quality as the dependent variable was analyzed by modeling it with the predictor variables, which are duration of talking on the phone at a time, talking on the phone while it is charging, and the place where the cell phone is kept while sleeping. The linear relationship between variables was evaluated by using collinearity statistics and there was perfect linear relationship between variables of the

model. For all analyses, a p value 0.05 was used as the limit of statistical significance.

Ethical Approach: Before conducting the study, written permission was received from Bozok University, Faculty of Medicine, Clinical Research Ethics Committee and Bozok University Presidency, and written consent was obtained from the participants.

Results

This section summarizes the cell phone use of the students and the factors influencing sleep quality. Average age of the students who participated in the study was 21.1 ± 1.8. 52.8% of the participants were male, and 38.8% of them were freshman students. All the students in the study had a cell phone. As far as the aims of students to use cell phones are concerned, it was found that all the students use their cell phones to communicate, while 57.45% use it to listen to music, 48.0% to take photographs, 41.4% to use the Internet, and 29.8% to watch videos. No relationship was found between the age and grade of the students, years of using a cell phone, and sleep quality. Average duration of cell phone use was 6.6 ± 2.4 years, and 46.0% of the students talk on the cell phone 21 minutes or more at a time; 6.1% often talk on the cell phone while it is charging; 77.2% mainly talk on the phone at night; and 67.2% put their cell phone near the bed or under the pillow while sleeping. Only 12.4% of the students stated that cell phones may have a negative impact on health (Table 1).

Table 1 Distribution of students based on the characteristics of cell phone use

Variables	n	%
Years of cell phone use	6.60 ± 2.40	
Daily average cell phone use (in minutes)	76.67 ± 73.79	
Duration of talking on the cell phone at a time		
Less than 10 minutes	259	24.9
10-20 minutes	302	29.0
21 minutes and more	479	46.0
The method of answering the phone		
I hold the phone close to my ear and answer it.	266	25.6
I answer the phone before holding it close to my ear.	774	74.4
Points considered while talking on a cell phone		
I talk on the phone holding it directly to my ear.	728	70.0
I talk on the phone holding it 1-2 cm away from my ear.	223	21.4
I talk on the phone with earphones.	89	8.6
Talking on the phone while charging		
Never	152	14.6
Rarely	403	38.8
Frequently	485	46.6
Prime time of cell phone use		
Between 8 am-10 pm	237	3.6
After 10 pm	802	77.2
The place where the cell phone is kept while sleeping		
Under my pillow or near the bed	699	67.2

Outside the room I sleep in	341	32.8
The place where the cell phone is carried		
In the pocket of my pants	701	67.4
In my bag	237	22.8
In the pocket of my shirt, close to my chest	102	9.8
Awareness about the negative effects of cell phone use on health		
Yes	129	12.4
No	540	51.9
I do not know	371	35.7
Symptoms associated with cell phone use *		
Fatigue	683	65.7
Headache	556	53.5
Temper	522	50.0
Forgetfulness	498	47.9
Lack of attention	477	45.9
Burning eyes	382	36.7
Tinnitus	333	32.0
Social isolation	330	31.7

*Participants can choose more than one symptom

Table 2 Distribution of Pittsburgh Sleep Quality Index components among students

Sleep Quality Components	X±SD
Subjective sleep quality	1.28 ± 0.77 (0-3)
Sleep latency	1.31 ± 0.77 (0-3)
Sleep duration	0.64 ± 0.99 (0-3)
Habitual sleep efficiency	1.38 ± 1.18 (0-3)
Sleep disturbances	1.30 ± 0.56 (0-3)
Use of sleep medication	0.09 ± 0.40 (0-3)
Daytime dysfunction	1.50 ± 0.93 (0-3)
Total PSQI	7.52 ± 3.21 (3-17)
Quality Sleep	≤5 (%29.1)
Poor Sleep	>5 (%70.9)

Table 3 Distribution of students based on the characteristics of cell phone use and PSQI

Variables	Subjective sleep quality	Sleep latency	Sleep duration	Habitual sleep efficiency	Sleep disturbances	Use of sleep medication	Daytime dysfunction	Total PSQI
Duration of talking on the cell phone at a time								
Less than 10 minutes	1.24±0.77	1.20±0.86	0.66±0.40	1.40±1.15	1.27±0.58	0.09±0.37	1.30±0.92	7.26±3.16
10-20 minutes	1.26±0.77	1.29±0.85	0.58±0.49	1.26±1.19	1.26±0.53	0.07±0.32	1.46±0.93	7.22±3.30
21 minutes and more	1.32±0.78	1.32±0.91	0.66±0.48	1.48±1.19	1.35±0.58	0.11±0.42	1.63±0.92	7.94±3.16
p	0.295	0.203	0.570	**0.032**	0.056	0.411	**0.000**	**0.013**
The method of answering the phone								
I hold the phone close to my ear and answer it.	1.24±0.76	1.40±0.87	0.60±0.37	1.38±1.19	1.26±0.54	0.09±0.42	1.48±0.95	7.50±3.20
I answer the phone before holding it close to my ear.	1.30±0.78	1.24±0.88	0.65±0.39	1.38±1.18	1.32±0.57	0.10±0.40	1.51±0.92	7.51±3.22
p	0.316	**0.008**	0.550	0.996	0.156	0.920	0.745	0.950
Points considered while talking on a cell phone								
I talk on the phone holding it directly to my ear.	1.32±0.78	1.31±0.90	0.64±0.37	1.34±1.18	1.30±0.56	0.08±0.36	1.52±0.93	7.53±3.20
I talk on the phone holding it 1-2 cm away from my ear.	1.22±0.77	1.20±0.82	0.64±0.39	1.52±1.19	1..35±0.54	0.11±0.53	1.42±0.92	7.45±3.19
I talk on the phone with earphones.	1.22±0.78	1.32±0.89	0.61±0.38	1.38±1.22	1.30±0.59	0.07±0.40	1.57±0.98	7.56±3.40
p	0.211	0.266	0.975	0.164	0.688	0.284	0.288	0.938
Talking on the phone while charging								
Never	1.17±0.83	1.26±0.89	0.63±0.38	1.55±1.22	1.17±0.55	0.03±0.24	1.34±0.98	7.16±3.17
Rarely	1.26±0.69	1.16±0.87	0.64±0.39	1.35±1.16	1.25±0.52	0.06±0.32	1.41±0.90	7.15±3.16
Frequently	1.33±0.80	1.36±1.38	0.64±0.37	1.36±1.18	1.38±0.59	0.13±0.48	1.59±0.93	7.80±3.24
p	**0.015**	**0.005**	0.991	**0.002**	**0.000**	**0.015**	**0.002**	**0.007**
Prime time of cell phone use								
Between 8 am-10 pm	1.34±0.77	1.16±0.84	0.69±0.36	1.41±1.19	1.30±0.60	0.09±0.38	1.42±0.98	7.43±3.15
After 10 pm	1.27±0.78	1.32±0.89	0.62±0.37	1.38±1.18	1.31±0.56	0.09±0.42	1.53±0.92	7.54±3.23
p	0.239	**0.015**	0.324	0.701	0.858	0.970	0.103	0.664
The place where the cell phone is kept while sleeping								
Under my pillow or near the bed	1.33±0.80	1.35±0.87	0.65±0.35	1.43±1.18	1.36±0.56	0.10±0.43	1.54±0.98	7.77±3.19
Outside the room I sleep in	1.20±0.73	1.16±0.88	0.61±0.33	1.29±1.19	1.20±0.53	0.07±0.36	1.42±0.92	6.97±3.21
p	**0.007**	**0.001**	0.490	**0.008**	**0.000**	0.351	**0.015**	**0.000**
The place where the cell phone is carried								
In the pocket of my pants	1.27±0.77	1.26±0.87	0.61±0.36	1.42±1.17	1.27±0.56	0.09±0.43	1.44±0.93	7.38±3.19
In my bag	1.32±0.78	1.33±0.88	0.68±0.33	1.31±1.20	1.39±0.57	0.10±0.37	1.63±0.92	7.78±3.21
p	0.313	0.235	0.320	0.175	**0.001**	0.698	**0.003**	0.052

Table 4 Characteristics of cell phone use associated with adolescents on sleep quality: Model multiple regression

	Model
Characteristics of cell phone use	**B**
Duration of talking on the cell phone at a time	0.88*
Talking on the phone while charging	.20**
The place where the cell phone is kept while sleeping	0.71*
R^2	0.7
F	7.538
p	0.000

*p<0.05 **p<0.01

It was revealed that the students who participated in the study received a score of 7.52±3.21 (Min:0-Max:17) from the Pittsburgh Sleep Quality Index and that 70.9% of the students have poor sleep quality (Table 2).

It was found that students who talk on the cell phone 21 minutes or more at a time have significantly higher total sleep quality index scores in habitual sleep efficiency ($p=0.042$), daytime dysfunction ($p<0.001$), and total sleep quality index scores ($p=0.013$). It was revealed that sleep latency scores of the students who answer the phone directly holding it close to their ears are high and statistically significant ($p=0.013$). Sleep latency ($p=0.005$), habitual sleep efficiency ($p=0.002$), sleep disturbance ($p<0.001$), use of sleeping medication ($p=0.015$), daytime dysfunction ($p=0.002$), and total sleep quality index scores ($p=0.007$) of the students who use their cell phone while it is charging were found to be significantly higher. Subjective sleep quality ($p=0.007$), sleep latency ($p=0.001$), habitual sleep efficiency ($p=0.008$), sleep disturbance ($p<0.001$), daytime dysfunction ($p=0.015$) and total sleep quality index ($p<0.001$) scores of the students who generally put their cell phone near the bed or under the pillow while sleeping were found to be significantly higher (Table 3).

Multiple regression was conducted to examine the contribution of significant duration of talking on the cell phone at a time, talking on the phone while charging and the place where the cell phone is kept while sleeping . The model was significant and explained 7% of the variance in sleep quality (Table 4). In this model, factors that remained strongly associated with sleep quality were high outcome and efficacy. The linear relationship between variables in each model was evaluated by using the collinearity statistics. In these analyses, it is desired to have Variance Inflation Factor (VIF) to be lower than 10 and the tolerance value to be higher than 0.2. The VIF values for the model were; between 1.040 and 1.096. The tolerance values for the between 0.91 and 0.96. The B values for the model 0.88, .20 and 0.71; respectively (Table 4).

Discussion

This study focuses on the relationship between the sleep quality of the university students and of cell phone over-use. It revealed that sleep quality of the students is poor, and over-use of mobile cell-phone reduce sleep quality. Emerging health risks associated with cell phone use are related to high toxic emissions from cell phones and exposure to electromagnetic frequencies (EMF) (Velmurugan, 2016; Velmurugan, 2017). Cell phone ownership is increasing among adolescents. It was revealed that 74.3% of the adolescents in Turkey use cell phones (Turkey Profile of Adolescent Research, 2013). According to a study conducted in Japan, the rate of cell of use of adolescents varies between 74.8% and 84.0% (Munezawa, Kaneita et al., 2011). In the current study, all the adolescents who are defined as the EMF exposure risk group

owned a mobile phone. In addition to keeping in contact with their families and friends, all the adolescents in the study used their cell phones to listen to music, take photographs, and use the Internet, respectively. Other studies in the literature also found that adolescents use their cell phones for the same purposes (Durusoy, Hassoy et al., 2017). The years of cell phone use was found to be 6.60±2.40 years, indicating that the participants started to use a cell phone at a very early age. Moreover, duration of daily cell phone use was found to be 76.67±73.79 minutes, which may pose health risks in the future as well. The studies in the literature argue that as the duration of cell phone use and talking time on the cell phone increase, people are overly exposed to EMF within radio-frequency range, which leads to depression, sadness, temper, headache, anxiety, forgetfulness, tinnitus, and decrease in sleep quality (Durusoy, Hassoy et al., 2017; Thomee, Harenstam & Hagberg, 2011; Velmurugan, 2017; Acharya, Acharya & Waghrey, 2013). In our study, when we asked the adolescents what effects they observed in themselves with the increase in cell phone use, more than half of them stated that they have experienced fatigue, while half of them said they have experienced such problems as headache, temper, forgetfulness and lack of attention. Aghav argues that these symptoms are detected due to the negative effects of electromagnetic frequencies which emerge as a result of the intensity of cell phone frequency (Aghav, 2014).

In their studies conducted on human subjects, Lowden et al. found that being exposed to EMF radiating from cell phones prior to and during sleep decreases REM (rapid eye movement) sleep (Lowden, Akerstedt & Ingie, 2011). Another study by Huber et al. revealed that exposure to EMF at night affects melatonin rhythm and brain activity, particularly the activity of the pineal gland, which leads to a change in cerebral blood flow and cerebral electrical activity, and consequently impairs sleep quality (Hubber, Treyer & Borbelly, 2002). The current study revealed that about 75 percent of the adolescents have poor sleep quality. In studies conducted with adolescents in various countries, developmental characteristics and uncontrolled use of cell phones have been shown to reduce sleep quality (Munezawa, Kaneita et al., 2011; Tao, Wu et al., 2017; Li, Lepp & Barkley 2015; Durusoy, Hassoy et al., 2017; Mohammadbeigi & Absari, 2016; Oz, Arslantaş, et al., 2015; Bruni,

Sette, et al., 2015; Demirci, Akgonul & Akpinar, 2015).

The multiple regression model explained 7% of the variance that talking on the cell phone 21 minutes or more at a time, putting the cell phone near the bed or under the pillow while sleeping, and talking on the cell phone while it is charging are more influential as the main determinants of the decrease in sleep quality, respectively. In their studies, Mohammadbeigi et al. found that cell phone addiction reduces sleep quality 4.5 times more (Mohammadbeigi & Absari, 2016). Oz et al., (2015) revealed that putting the cell phone near the bed while sleeping reduces sleep quality. When the over-use of mobile cell-phone which affect sleep quality are concerned, Lowden and Huber found that talking on the phone for a long time at a time, putting the cell phone near the bed, and talking on the cell phone while it is charging mean that cell phone is held close to the head for a long time and thus, brain may be affected by the EMF (Lowden, Akerstedt & Ingie, 2011; Hubber, Treyer & Borbelly, 2002). Furthermore, it was maintained that holding the cell phone close to the same ear for more than 5-10 minutes poses some health risks. With the temperature increase in this part of the brain, structural changes may occur in the cells, which may lead to headache, temper, sleep deprivation, lack of attention, and structural changes in cells. Thus, it is advisable not to hold cell phone close to the same ear for more than 5-10 minutes. Furthermore, calling or talking on the cell phone while it is charging was found to be another factor affecting sleep quality negatively. Talking on the phone while it is charging means being exposed to both radio frequencies and EMF (Tao, Wu et al., 2017; Durusoy, Hassoy et al., 2017). The current study further revealed that students who mainly talk on the phone while it is charging have significantly higher sleep latency, habitual sleep efficiency, sleep disturbances, use of sleep medication, daytime dysfunction and total sleep quality index scores compared to those who do not.

The students who participated in the study stated that they mostly use their cell phone after 10 pm. It was further found that sleep latency scores of the students who used their cell phone mostly at night were higher compared to those who did not. Various studies reached similar results (Tao, Wu et al., 2017; Durusoy, Hassoy et al., 2017; Thomee, Harenstam & Hagberg, 2011; Oz, Arslantaş et al., 2015). Those who are engaged

with their cell phones all night choose to sleep during the day, and thus, they exhibit symptoms like stress, anxiety, depression, fatigue, headache and temper more due to the disturbed balance between melatonin and serotonin [Tao, Wu et al., 2017; Bruni, Sette, et al., 2015; Demirci, Akgonul & Akpinar 2015).

This study has some limitations while revealing new findings. It is recommended that the number of participants be increased in future studies with a multi-center design involving cultural-economic differences and different of cell phone over-use.

The current study revealed that the incorrect and excessive use of cell phones leads to headache, forgetfulness, fatigue and temper in adolescent university students by reducing sleep quality. If these symptoms in adolescents continue, they may lead to obesity and risk of chronic diseases like heart disease and diabetes at older age. Thus, preventive measures must be taken and education must be given to adolescents in order to ensure correct use of cell phones during the adolescence period.

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