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Mobile Phone Use and Risk of Adverse Health Impacts among Medical Students in Jeddah, Saudi Arabia

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Authors' contributions

This work was carried out in collaboration between all authors. All authors designed the study, wrote the protocol, wrote the first draft of the manuscript and analyses of the study. All of them read and approved the final manuscript.

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ABSTRACT

Background: Internationally, there is growing concern about the adverse health effects of mobile phone use by young people.
Aim: To determine the pattern of mobile phone use among medical students and determine the potential association between degree of use and self-reported health impacts.
Methods: A cross-sectional study was carried out on 472 medical students in King Abdulaziz

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University. Self-administered specially designed questionnaire was used to collect data regarding the following: Socio-demographic characteristics, pattern of phone use and self-reported health complaints.

Results: The students' median duration of mobile phone use was 330 min/day and was significantly higher in females (*P*= 0.04). A positive significant correlation was observed between the health complaints score and the average daily duration of use (r =0.139, *P*=0.002). Adjusted multiple logistic regression analysis revealed that heavy mobile use was significantly associated with self-reported sleep disturbances, headache (AOR=4.76), fatigue (AOR=4.67), depression (AOR=2.63), nervousness (AOR=1.64), musculoskeletal pain (AOR=2.14) and visual problems (AOR=2.40).

Conclusion: mobile phone use occupies a significant part in the daily life of medical students. The heavy use of mobile phone in calling and non-calling activities was associated with a high level of subjective health complaints with dose dependent pattern. After controlling for other important predictors, heavy mobile use was associated with sleep disturbances, headache, depression, nervousness, eye and musculoskeletal problems. Excessive use of mobile phones should be avoided and social awareness increased through health education activities. In addition, employing a speaker-phone device for longer daily use and recommended parental procedures are taken to prevent young people being woken by their mobile phones.

Keywords: Medical students; mobile phone; self-reported outcomes; sleep disturbances.

1. INTRODUCTION

Mobile phone use has increased rapidly in the last two decades. In 2010, global mobile phone ownership reached five billion, and this number is expected to rise to 50 billion by 2020. The use of mobile phones is quite common among the university students and many of them considered it as their necessity of life [1].

Internationally, there is growing concern about the adverse health effects of mobile phone use by young people [2]. Several studies have expressed caution about possible health outcomes from the increasing exposure to electromagnetic radiation accompanying its use [3].

Self-reported mental and subjective health complaints such as pain, sleeping problems, anxiety, and various stress-related problems are common and seem to have increased over time among older adolescents, especially girls and are associated with heavy mobile phone use [4].

Heavy mobile phone use (overuse) has been associated with somatic complaints, anxiety, insomnia, depression and unhealthy lifestyle [5,6].

According to Vision Council, more than a third of U.S. adults reported spending four to six hours a day with smart phone and other hand-held digital devices, which may increase potential vision problems, including eye strain [7]. Furthermore, ergonomic problems associated with mobile phone use in text writing may result in several musculoskeletal symptoms including back pain and neck pain [8].

By end of 2010, there were 51.6 million mobile-cellular subscriptions in Saudi Arabia, translating into a penetration rate of 187.9 per cent. During the first six months of 2011, mobile-cellular subscriptions increased by 6.7 per cent, as 3.444 million subscriptions were added. By the end of June 2011, Saudi Arabia's total mobile-cellular subscriptions stood at 55 million. This corresponds to a penetration rate of 198.1 per cent, which is the highest in the Arab region and among the highest in the world [9].

According to the best of our knowledge, no epidemiologic study has been done in Jeddah, Saudi Arabia, to detect a possible association between pattern of mobile phone use and health impacts among medical students. The aim of this study is to determine the pattern of mobile phone use among medical students and determine the potential association between degree of use and self-reported health impacts.

2. MATERIALS AND METHODS

2.1 Study Setting

The study was carried out in the Medical College of King Abdulaziz University (KAU), in both male and female sections, during the academic year 2014–2015. A total of about 1000 students were

enrolled in the Medical College in this academic year. The study in Medical College is extended over six academic years. In the first academic year, students are not related to Medical College, rather they taught in Science College, so that they were not included in the current study. Study from the second to sixth academic is conducted in two phases; pre- clinical phase includes second and third academic years and clinical phase includes the fourth to sixth academic years. Ethical approval was obtained from the Institutional Review Board of the KAU. Oral consent was obtained from students. They could select to opt out and they could also reject to answer questions. Any collected information was kept confidential.

2.2 Study Design and Sampling

A cross-sectional study was conducted on a representative sample of students randomly selected from Medical College through stratified cluster sampling. The sample size was calculated using WHO manual for sample size determination in health studies considering an anticipated population proportion of heavy mobile use of 50% and an absolute precision of 5% at a 95% confidence, the minimal sample size required for the study was estimated to be 287 students. To account for possible non-responses, a total sample of 450 students was initially planned to be included in the present study.

The target population was male and female students of Medical College in KAU. From the pre- clinical phase, the third academic year was chosen randomly to be included in the study while, the fourth and fifth years were chosen randomly from the clinical phase. From each academic year, a section or group (cluster) was randomly chosen by simple random sampling. All students in the chosen clusters were included. A total of 500 students were registered in the chosen clusters. The response rate was 94.4% (472/500). Reasons for non-participation were absence during the study period, incomplete questionnaires and lack of interest in the study.

2.3 Study Tools

A questionnaire was constructed by the researchers after reviewing the literature related to cell-phone reported symptoms [1-4] and the WHO Health Behaviour In School-aged Children (HBSC) checklist [10]. The anonymous, self-administered questionnaire was used to collect data regarding the following: Socio-demographic characteristics (age, sex, academic year, type of residence and family income); patterns of mobile use including self-reported type and duration of daily mobile phone use (average call frequency and total time in minutes per day, average non-call smart phone use frequency and total time in min/day and average total time of daily mobile phone use in min/day) and self-reported health impacts.

The non-call smart phone use includes: sending and receiving SMS, games and social media.

The self-reported health impacts were drawn from the WHO Health Behaviour In School-aged Children (HBSC) checklist [10] and include: sleep complaints (delayed onset of sleep -after 12 midnight-, frequent wake up at night, and short sleep duration (less than 8 hours/night), mental health complaints (depression, nervousness and fatigue), headache, musculoskeletal pain (hand and wrist, neck and back pain) and eye complaints (blurring of vision and eye redness). According to the frequency in the preceding week, each complaint has been given scores from zero to three (0=absent, 1=one to two times/week, 2=three to four times/ week, 3 = more than four times /week). Frequent complaint has been considered when the frequency was 3 or more. The complaint score was tested for reliability using Cronbach's Alpha test for internal consistency. The questionnaire has been examined for content validity and the coefficient of Cronbach's alpha was found to equal 0.65. This was acceptable for reliability of newly applied questionnaire according to Churchill and Peter [11]. A value of alpha below 0.6 is undesirable. Nunnally (1978 and 1988) assumed that for newly developed measurement, alpha value above 0.6 can be accepted, otherwise 0.7 should be the threshold [12-13].

Possible confounding influences were considered as age, sex, having recently had a cold or flu, usual bedtime, TV in the bedroom and cell-phone storage.

2.4 Data Entry and Analysis

The data were analyzed using *SPSS*, version 22. Continuous data were presented as mean, standard deviation (SD), median and range. They were compared using Student t-test and Mann–Whitney-U test for parametric and nonparametric data respectively. The pattern of mobile phone use was divided arbitrarily according to the median cutoff point. Mobile

phone use above the median was considered as heavy use. Sociodemographic determinants of mobile phone use were examined using Chi-square test. Person's correlation test was used to assess the relation between total complaint score and the pattern of mobile phone use. Multiple regression analysis test was used to find out the association between heavy mobile use and the development of each medical complaint. The adjusted odds ratios for age, sex, economic level, residence and academic year and their 95% confidence interval (C.I) were calculated. P < 0.05 was considered statistically significant.

3. RESULTS

Age of participating students ranged from 19 to 25 years, with a mean of 21 (SD 1.15) years. They were proportionally distributed on the different levels of Medical College in KAU and were nearly equally distributed in gender (48.7% male and 51.3% female). Most of them were house owners (83.9%) and belonging to high social class (66.3%) (Table 1).

Table 1. Socio-demographic characteristics of the studied students (n=472)

Socio-demographic criteria	N (%)
• **Age (years)**	
Mean±SD	21.00±1.15
Range	(19-25)
• **Academic year**	
3nd year	178 (37.7)
4th year	187 (39.6)
5th year	107 (22.7)
• **Sex**	
Male	230 (48.7)
Female	242 (51.3)
• **Housing**	
Owner	396 (83.9)
Rent	76 (16.1)
• **Social class**	
High	313 (66.3)
Middle	147 (31.1)
Low	12 (2.5)

3.1 Pattern of Mobile Phone Use

According to Table 2, the students' average duration of owning mobile phone was 7.84 years (SD=1.95) with median duration of 8.00 years and without statistically significant difference in gender. Meanwhile, the average duration of having smart phone was 4.43 years (SD=1.38) with median duration of 4.00 years and it had a significantly higher duration among females. The median frequency and duration of calls per day were 4.00 times and 30 min/day, respectively and were not significantly related to gender. On the other hand, the median frequency and duration of non- call smart phone use per day were 28.00 times and 300 min/day, respectively. While, frequency of use was significantly higher in males, the total duration was significantly higher in females. The median total duration of mobile phone use per day was 330 min/day and was significantly higher in females.

3.2 Determinants of Heavy Mobile Phone Use

Age group >21 years was significantly associated with frequent calls per day (P = 0.003). Being male student was significantly associated with frequent smart phone use (p=0.002) while being female student was significantly associated with frequent longer duration of smart phone use (P=0.05) and heavy mobile phone use (P=0.003). Also, low socioeconomic level was associated with higher frequency of non-call smart phone use. On the other hand, academic level was not significantly associated with heavy mobile phone use (Table 3).

3.3 Health Association of Heavy Mobile Phone Use

Weak positive significant correlations were observed between the total health complaints score and both the duration of non- call smart phone use min per day (r =0.139, P=0.002) and the total duration of mobile phone use (r=0.133, P=0.004) (Figs. 1 and 2, respectively).

The adjusted multiple logistic regression analysis for the mobile phone predictors of sleep problem is revealed in Table 4. The association of delayed onset of sleep was significantly higher with longer duration of calls in min per day (AOR=2.49), frequent non-call smart phone use (AOR=2.28), longer duration of non-call use (AOR=3.32), total duration of daily mobile phone use (AOR=1.9), place of the phone under the pillow (AOR=8.93), and in the side of the bed (AOR=8.31). Moreover, the association of frequent wakeup at night was significantly higher with duration of call in min per day (AOR=2.62), and frequent non-call smart phone use (AOR=2.77). Interestingly, the association of short sleep was significantly increased with longer duration of non-call smart phone use in minutes per day (AOR=5.06), and total duration of mobile phone use (AOR=1.66).

Table 2. Pattern of mobile phone use among the studied students (n=472)

Pattern	Students N= 472		Male N=230	Female N=242	*P*-value
	Mean ±SD	Median (range)	Mean ±SD	Mean ±SD	
Duration of owning mobile phone (years)	7.84±1.95	8.00 (4-15)	7.88±1.89	7.80±2.02	0.56
Duration of smart phone use (years)	4.43±1.38	4.00 (2-10)	4.27±1.30	4.59±1.44	0.01
Frequency of calls per day	5.5±4.6	4.00 (1-30)	5.75±4.83	5.29±4.49	0.28
Duration of calls (minutes/day)	32.60±24.63	30(1-180)	34.03±26.50	31.23±22.68	0.21
Frequency of non-call use of smart phone per day	26.03±15.96	20 (5-100)	28.60±17.53	23.58±13.92	0.001
Duration of non-calling Use (minutes/ day)	326.44±127.18	300(120-1200)	313.56±113.27	338.67±138.24	0.03
Duration of mobile phone Use (min/day)	359.03±133.43	330(140-1260)	347.60±119.82	369.90±120.20	0.04

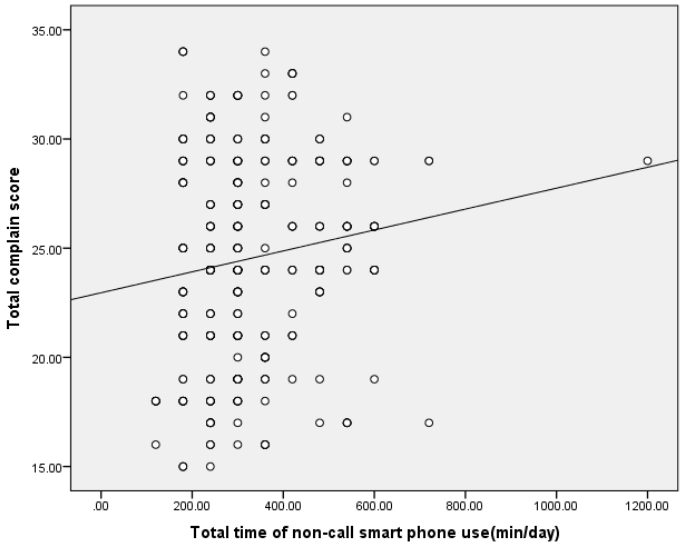

Fig. 1. Scatter-plot chart for the correlation between total time of non-call smart phone use (min/day) and the total complain score

The mobile phone usage predictors of mental health outcomes and other outcomes are presented in Table 5. The association of depression is increased significantly with longer duration of calls (min/day) (AOR=2.63), and longer duration of mobile phone use (min/day) (AOR= 2.1). Furthermore, the association of nervousness was significantly higher with longer duration of mobile phone (AOR=1.64). The association of fatigue was significantly higher with longer duration of non-call smart phone use (AOR=4.67), longer duration of mobile phone use (AOR=1.64) and placing the phone under the pillow (AOR=16.48) and in the side of the bed (AOR=5.06). In addition, the association of headache was significantly higher with longer

time of non-call smart phone (min/day) (AOR=4.76).

Multiple logistic regression analysis for the mobile phone predictors of musculoskeletal and eye complaints have been presented in Table 6. The association of neck pain was significantly increased with frequent calls per day. On the other hand, the association of back pain and blurring of vision were significantly increased with longer duration of calls (AOR=2.14 and 2.40, respectively) and longer duration of non-call smart phone use (AOR= 8.63 and 13.14, respectively). Meanwhile, the association of eye redness was significantly higher with longer duration of non-call smart phone use (AOR=3.63).

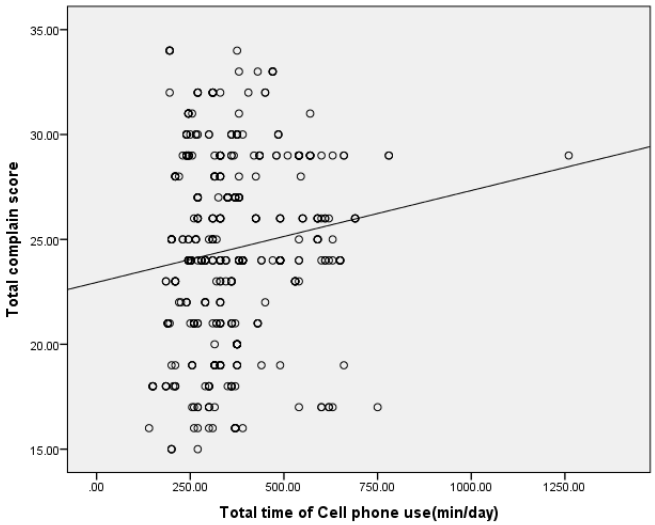

Fig. 2. Scatter-plot chart for the correlation between total time of cell-phone use (min/day) and the total complain score

Table 3. Determinants of heavy mobile phone use among the studied students (n=472)

		Heavy use [a]				
	Total N (%)	**Frequency of calls /day N (%)**	**Duration of calls (min/day) N (%)**	**Frequency of non- call use/day N (%)**	**Duration of non-calls (min/day) N (%)**	**Duration of mobile phone use (min/day) N (%)**
Age (years)						
<21	164(100)	91(55.5)	82(50.0)	107(65.9)	108(65.9)	98(59.8)
>21	308(100)	213(69.2)	173(56.2)	210(68.2)	186(60.4)	156(50.6)
P-value		0.003*	0.21	0.54	0.27	0.06
Gender						
Male	230(100)	157(68.3)	126(54.8)	170(73.9)	133(57.8)	112(48.7)
Female	242(100)	147(60.7)	129(53.3)	147(60.7)	161(66.5)	142(58.7)
P-value		0.10	0.78	0.002*	0.05*	0.003*
Social level						
High	313(100)	202(64.5)	173(55.3)	221(70.6)	201(64.2)	167(53.4)
Middle	147(100)	90(61.2)	75(51.0)	85(57.8)	88(59.9)	82(55.8)
Low	12(100)	9(75.0)	7(58.3)	11(91.66)	5(41.7)	5(41.7)
P-value		0.56	0.66	0.005*	0.22	0.61
Academic year						
3rd	178(100)	105(59.0)	98(55.1)	113(63.5)	117(65.7)	106(59.6)
4 th	187(100)	123(65.8)	101(54.0)	123(65.8)	115(61.5)	96(51.3)
5th	107(100)	76(71.0)	56(52.3)	66(61.7)	62(57.9)	52(48.6)
P-value		0.10	0.91	0.92	0.40	0.13

[a]*Above the median, * statistically significant (p<0.05)*

Table 4. Multiple logistic regression for the mobile phone predictors of sleep problems among the studied students (n=472)

Phone use parameters [a]	Delayed onset of sleep AOR[b] (95% C.I)	Wake up at night AOR[b] (95% C.I)	Short sleep duration AOR[b] (95% C.I)
Number of calls /day	0.69(0.39-1.23)	0.87(0.47-1.62)	1.14(0.68-1.91)
Duration of calls (min/day)	2.49(1.24- 5.00)	2.62(1.46-4.71)	1.21(0.76-1.94)
Number of non- call use/day	2.28(1.14-4.53)	2.77(1.45-5.31)	0.92(0.560-1.52)
Duration of non-call phone use(min/day)	3.32(1.31-8.40)	1.85(0.73-4.68)	5.06(2.08 -12.34)
Total duration of mobile phone use(min/day)	1.9(1.67-4.46)	0.87(0.59-1.29)	1.66 (1.45-2.98)
Place of phone			
Outside bedroom	r	r	r
In the side of the bed	8.31 (1.09- 63.11)	-	1.15(0.42- 3.14)
Under the pillow	8.93(1.11- 71.79)	-	0.40(0.13- 1.20)

[a]The reference groups were low use categories compared with heavy use, [b]AOR = Adjusted odds ratio (regarding; age, sex, residence, socioeconomic status and residence), C.I= Confidence Interval

Table 5. Multiple logistic regression for the mobile phone predictors and mental health outcomes and other outcome of the studied students (n=472)

Phone use parameters [a]	Headache AOR (95% C.I)	Depression AOR (95% C.I)	Nervousness AOR (95% C.I)	Fatigue AOR (95% C.I)
Number of calls /day	0.76(0.47-1.25)	0.16(0.07-0.36)	0.24(0.13-0.45)	0.64(0.388-1.07)
Duration of calls (min/day)	0.90(0.46-1.73)	2.63(1.32-5.24)	1.01(0.58-1.71)	1.06(0.66-1.69)
Number of non- call use/day	1.16(0.58-2.34)	0.84(0.43-1.66)	1.49(0.83-2.67)	0.86(0.58-1.28)
Total duration of non-call phone use (min/day)	4.76(1.65-13.72)	1.37(0.84-2.40)	1.6(0.72-1.80)	4.67(1.92-11.35)
Total duration of mobile phone use (min/day)	1.1(0.67-1.72)	2.1(1.28-3.43)	1.64(2.54-71.92)	1.64(1.41-2.31)
Place of phone	r	r	r	
In the side of the bed	-	-	-	5.06(1.62-15.84)
Under the pillow	-	-	-	16.48(4.38-61.99)

[a]The reference groups were low use categories compared with heavy use,
[b]AOR = Adjusted odds ratio (regarding; age, sex, residence, socioeconomic status and residence), C.I= Confidence Interval

Table 6. Multiple logistic regression for the mobile phone predictors of musculoskeletal and eye complaints among the studied students (n=472)

Phone use parameters [a]	Hand and wrist pain AOR (95% C.I)	Neck pain AOR (95% C.I)	Back pain AOR (95% C.I)	Blurring of vision AOR (95% C.I)	Eye redness AOR (95% C.I)
Number of calls /day	0.93 (0.63-1.65)	4.01 (1.72-9.37)	1.35 (0.60-3.02)	1.02 (0.46-2.25)	0.52 (0.15-1.86)
Duration of calls (min/day)	1.85 (0.74-4.64)	0.87 (0.45-1.32)	2.14 (1.01-4.56)	2.40 (1.15-4.98)	1.06 (0.32-3.51)
Number of non- call use/day	1.63 (0.63-4.26)	0.33 (0.15-0.75)	1.21 (0.58-2.54)	0.92 (0.44-1.92)	0.83 (0.08-9.01)
Total time of non-call use(min/day)	2.12 (0.62-7.22)	1.10 (0.37-3.27)	8.63 (2.94-25.36)	13.14 (4.39-39.28)	3.63 (1.1-14.45)
Total time of Cell phone use(min/day)	0.85 (0.68-1.98)	0.72 (0.23-2.27)	0.34 (0.13-0.93)	0.95 (0.78-2.56)	1.84 (0.18-19.16)

[a]The reference groups were low use categories compared with heavy use, [b]AOR = Adjusted odds ratio (regarding; age, sex, residence, socioeconomic status and residence), C.I= Confidence Interval

4. DISCUSSION

The study surveyed the amount of mobile phone usage among KAU Medical College students and examined its associations with subjective health complaints. The students' median duration of mobile phone use was 330 min/day (5.5 hrs per day). This result indicated that the students spent a considerable amount of their life in using the mobile phone. This was consistent with the result of some studies [14,15].

The current study revealed that the total duration of mobile phone use, particularly smart phone use was significantly higher in female students. Studies found that the females have more heavy use of the mobile phone than males do, with the most pronounced difference occurring for text message use and they are also more prone to experience dependence on the mobile phone [16-18]. A study designed to unravel the causes of girls' excessive use of mobile phones demonstrated that females used their phones more frequently than men to satisfy their need for acceptance and closeness, as much as to establish and sustain social relationships, and to express their emotions [19]. Similarly, another study in Polish University students found that female students used their mobile phones more to socialize, to gossip and as a safety device [20].

The frequent non-call smart phone use was significantly associated with low socioeconomic status. Brown et al. [21] found that lower income students' use of their mobile devices for the Internet was significantly higher than that of students who had higher family earnings. This may be explained by the fact that lower income students lack access to other information technologies, such as PCs and tablets and accept mobile phone as an alternative to access the Internet. Similarly another study found that lower income groups in the United States and in developing countries usually used mobile technology before any other users due to the lack of access to other wireless communication technology [22]. On the contrary, a study found a positive correlation between family income and heavy mobile phone use [14].

In the present study, a weak positive significant correlation was observed between the total health complaints score and the duration of non-call smart phone. Self-reported health impacts were assessed by a study which found negative health effects of mobile phone use, including headache, fatigue and sleep disturbances [1]. However, electromagnetic frequency (EMF) exposure due to mobile phone use is not claimed by some researchers to have any major health effects [23]. Different factors have been discussed as illustrators of the association between heavy mobile phone use and negative health effects including anxiety, interrupted sleep and insomnia, depression [5], stress [24], unhealthy lifestyle [6] and ergonomic related health problems [8].

In the current study, by adjusting to the logistic regression model, the parameters of the heavy mobile phone for calling and smart use were associated with sleep disturbances, delayed onset of sleep, interrupted sleep and short sleep duration. This was in accordance with a previous study conducted by Thomée et al. [25] who found a significant association between heavy mobile use and sleep disturbances. Furthermore, a National Japanese study found a significant association between all sleep disturbances and mobile phone use for calling and for sending text messages after lights out, after adjusting for other confounders. It has been suggested that the heavy mobile use particularly in pre-sleep period influences physiologic factors such as the sleep electroencephalogram and melatonin-secretion rhythm. Moreover, using a mobile phone after lights out (lights off in the room) may induce emotional or cognitive arousal in the pre-sleep period that is considered to be a cause of insomnia symptoms [26].

Interestingly, the presence of mobile phone sets under and in the side of the pillow significantly has been shown to increase the association of insomnia among the studied students. A study reported that exposure to electromagnetic fields emitted by digital mobile-phone handsets prior to sleep decreased the rapid eye movement (REM) sleep latency and increased the electroencephalogram spectral power in the frequency range 11.5- to 12.25-Hz during the initial part of sleep following exposure [27]. Furthermore, another study reported that there was no significant difference in total night time melatonin output relative to mobile phone emission exposer, while the pre-bedtime melatonin output was significantly lower which indicates a delay in the onset time of melatonin secretion caused by mobile phone radiation [28].

In the present study, the association of headache was significantly higher with mobile phone over use in non-call communication indicating a possible dose dependent risk. This was in agreement with several studies reporting

consistent associations between headache and mobile phone overuse [29-31]. The possible explanation for this apparent link was given by Frey who noted the involvement of the blood-brain barrier and the dopamine-opioid systems of the brain in headaches, both of which have been linked to Radio Frequency Electro-Magnetic Fields (RF-EMF) exposures similar to those from cell-phones [32]. Another explanation of that observed association was eyestrain symptoms related to hand use devices.

In the current study, the association of self-reported depression and nervousness was found to be significantly elevated with total mobile overuse and in particularly long calls. This was consistent with the results of several studies [6,25]. As observed in Frey study [32], mobile overuse was associated with mental overload, disturbed sleep, the feeling of never being free, role conflicts, and feelings of guilt due to inability to return all calls and messages. All these factors may result in unfavorable mental outcome particularly depression and nervousness.

Interestingly, the association of fatigue was observed to be significantly higher with heavy mobile phone use and placing the phone under the pillow and in the side of the bed. Several studies had found that, fatigue is a predominant symptom among the excessive mobile phone users which might be related to the electromagnetic radiations emitted from the phone [3,25,31]. The distance dependent association observed in the current study may help in proving the association of fatigue with the intensity of electromagnetic radiation field.

In the current study, the association of neck and back pain was significantly higher among students with heavy mobile use in frequent calls and with longer durations of calls and non-calls use, respectively. Bad ergonomics during intensive mobile phone use in texting, games and social interaction beside the associated mental overload may give explanation to the musculoskeletal symptoms [25].

The association of blurred vision and eye redness were significantly increased with heavy mobile use especially with longer duration of non-call smart phone use. A significant dose dependent association was detected between the smart phone use and eye strain symptoms including blurred vision and eye redness [33]. The eye symptoms may be related to the mobile phone electromagnetic radiation [34], eye strain from overuse and glaring from the hand held displays [35].

5. CONCLUSION

The findings of this study indicate that mobile phone use occupy a large part in the daily life of medical students. The heavy use of mobile phone in calling and non-calling was associated with high level of subjective health impacts with dose dependent pattern. After controlling for other important predictors, heavy mobile use was associated with sleep disturbances, headache, depression, nervousness, eye and musculoskeletal problems. Thus, it is suggested that excessive use of mobile phones should be avoided and social awareness increased through health promotion activities, such as group discussions or public presentations, and via electronic and printed media sources. In addition, employing a speaker-phone device for longer daily use and recommended parental procedures are taken to prevent young people being woken by their mobile phones.

Our study had several strengths. The sample was representative and there was a high response-rate among the students. However, there were some limitations. First, since this was a cross-sectional study, a causal relationship could not be determined. Prospective and biological studies are recommended to prove the causal relationship. Furthermore, the use of self-reports for mobile use assessment as well as for health impacts assessment may raise some reliability and validity questions. It is important to emphasize that the study concerns to subjective symptom-reports and not actual disorders or diagnoses.

CONSENT

Oral consent was obtained from the participating before completing the questionnaire.

ETHICAL APPROVAL

Consent was obtained from the Institutional Review Board of the KAU. Jeddah Saudi Arabia. Participation in the study was voluntary and nobody was coerced into participation. The data will be Confidential and used only in this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Al-Barashdi HS, Bouazza A, Jabr NH. Smartphone addiction among Sultan Qaboos University Undergraduates. Journal of Social Sciences Research. 2015;5(2):724-40.
2. Thomas S, Kühnlein A, Heinrich S, Praml G, Kries R, Radon K. Exposure to mobile telecommunication networks assessed using personal dosimetry and well-being in children and adolescents: The German MobilEe-study. Environmental Health. 2008;7:54.
3. Redmayne M, Smith E, Abramson MJ The relationship between adolescents' well-being and their wireless phone use: A cross-sectional study. Environmental Health. 2013;12:90.
4. Friberg P, Hagquist C, Osika W. Self-perceived psychosomatic health in Swedish children, adolescents and young adults: An internet-based survey over time. BMJ Open. 2012;2(e000681):1–6.
   DOI: 10.1136/ bmjopen-2011-000681
5. Jenaro C, Flores N, Gómez-Vela M, González-Gil F, Caballo C. Problematic internet and cell-phone use: Psychological, behavioral and health correlates. Addiction Research and Theory. 2007;15(3):309-320.
6. Yen CF, Tang TC, Yen JY, Lin HC, Huang CF, Liu SC, Ko CH. Symptoms of problematic cellular phone use, functional impairment and its association with depression among adolescents in Southern Taiwan. Journal of Adolescence. 2009;32(4):863-873.
7. Wolff RJ. Health Risks of Using Mobile Phones; 2011.
   Available:http://source.southuniversity.edu/health-professionals.aspx
8. Gustafsson E, Johnson PW, Hagberg M. Thumb postures and physicalloads during mobile phone use - a comparison of young adults withand without musculoskeletal symptoms. Journal of Electromyography and Kinesiology. 2010;20(1):127-135.
9. International Telecommunication Union. Connect Arab Summit 2012: Statistical factsheet. Geneva, Switzerland; 2012. Available:http://www.itu.int/net/newsroom/connect/arab/2012/reports/statistical_overview.aspx
10. Haugland S, Wold B, Stevenson J, Aaroe LE, Woynarowska B. Subjective health complaints in adolescence: A cross-national comparison of prevalence and dimensionality. Eur J Publ Health. 2001; 11(1):4–10.
11. Churchill GA. Research design effects on the reliability of rating scales: A meta-analysis. Journal of Marketing Research. 1984;360-75.
12. Nunnally JC. Psychometric theory. New Jersey. McGraw-Hill Publishing; 1979.
13. Nunnally JC. Psychometric theory. New Jersey. McGraw-Hill Publishing; 1988.
14. Zulkefly SN, Baharudin R. Mobile phone use amongst students in a university in Malaysia: Its correlates and relationship to psychological health. European Journal of Scientific Research. 2009;37(2):206-18.
15. Nurvitadhi E. Trends in mobile computing: A study of mobile phone usage in the United States and Japan; 2002.
   Available:http://socio.ch/mobile/index_mobile.htm
   (Retrieved on 19 th September, 2005)
16. Chóliz M. Mobile-phone addiction in adolescence: The Test of Mobile Phone Dependence (TMD). Prog Health Sci. 2012;2(1):33-44.
17. Lepp A, Barkley JE, Karpinski AC. The relationship between cell phone use and academic performance in a sample of US College Students. SAGE Open. 2015;5(1): 2158244015573169.
18. Sánchez-Martínez M, Otero A. Factors associated with cell phone use in adolescents in the community of Madrid (Spain). Cyberpsychol Behav. 2009;12(2): 131–7.
19. Pawłowska B, Potembska E. Gender and severity of symptoms of mobile phone addiction in polish gymnasium, secondary school and university students. Curr Probl Psychiatry. 2011;12(4):433-38.
20. Balakrishnan V, Raj RG. Exploring the relationship between urbanized Malaysian youth and their mobile phones: A quantitative approach. Telematics and Informatics. 2012;29(3):263–272.
21. Brown K, Campbell SW, Ling R. Mobile phone bridging the digital divide for teens in the US? Future Internet. 2011;3:144-58.
22. Rice RE, Katz JE. Comparing internet and mobile phone usage: Digital divides of usage, adoption and dropouts. Telecommunications Policy. 2003;27:597–623.

23. SSM: Recent Research on EMF and Health Risks. Sixth annual report from SSM: Independent Expert Group on Electromagnetic Fields. SSM Report 2009:36 Swedish Radiation Safety Authority; 2009.
24. Beranuy M, Oberst U, Carbonell X, Chamarro A. Problematic internet and mobile phone use and clinical symptoms in college students: The role of emotional intelligence. Computers in Human Behavior. 2009;25(5):1182-1187.
25. Thomée S, Harenstam A, Hagberg M. Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults: A prospective cohort study. BMC Public Health. 2011;11(1):66.
26. Munezawa T, Kaneita Y, Osaki Y, Kanda H, Minowa M, Suzuki K, et al. The association between use of mobile phones after lights out and sleep disturbances among Japanese adolescents: A nationwide cross-sectional survey. Sleep. 2011;34(8):1013-1020.
27. Loughran SP, Wood AW, Barton JM, et al. The effect of electromagnetic fields emitted by mobile phones on human sleep. Neuroreport. 2005;16:1973-6.
28. Wood AW, Loughran SP, Stough C. Does evening exposure to mobile phone radiation affect subsequent melatonin production? Int J Radiat Biol. 2006;82:69-76.
29. Gau SF, Soong WT. Sleep problems of junior high school students in Taipei. Sleep. 1995;18:667-73. 6.
30. Liu XC, Uchiyama M, Okawa M, et al. Prevalence and correlates of self-reported sleep problems among Chinese adolescents. Sleep. 2000;23:27-34.
31. Johansson A, Nordin S, Heiden M, Sandström M. Symptoms, personality traits and stress in people with mobile phone-related symptoms and electromagnetic hypersensitivity. Journal of Psychosomatic Research. 2010,68(1):37-45.
32. Frey A. Headaches from cellular telephones: Are they realand what are the implications? Environ Health Perspect. 1998;106(3):101-103.
33. Meo SA, Al-Drees AM. Mobile phone-related hazards and subjective hearing and vision symptoms in the Saudi population. Int J Occup Med Environ Health. 2005;18(1):53–7.
34. Parazzini M, Bell S, Thuroczy G, Molnar F, Tognola G, Lutman ME, Ravazzani P. Influence on the mechanisms of generation of distortion product otoacoustic emissions of mobile phone exposure. Hear Res. 2005;208(1–2):68–78.
35. Moscot H. Healthy Vision with Hand-Held Devices. Available:http://nebraska.aoa.org/documents/ne/Healthy-Vision-Hand-Helds (Accessed in 25 May, 2015)

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