Original Research Article

Smartphone usage and increased risk of mobile phone addiction: A concurrent study

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Abstract

Objective: This study aimed to study the mobile phone addiction behavior and awareness on electromagnetic radiation (EMR) among a sample of Malaysian population.

Methods: This online study was conducted between December 2015 and 2016. The study instrument comprised eight segments, namely, informed consent form, demographic details, habituation, mobile phone fact and EMR details, mobile phone awareness education, psychomotor (anxious behavior) analysis, and health issues. Frequency of the data was calculated and summarized in the results.

Results: Totally, 409 respondents participated in the study. The mean age of the study participants was 22.88 (standard error = 0.24) years. Most of the study participants developed dependency with smartphone usage and had awareness (level 6) on EMR. No significant changes were found on mobile phone addiction behavior between the participants having accommodation on home and hostel.

Conclusion: The study participants were aware about mobile phone/radiation hazards and many of them were extremely dependent on smartphones. One-fourth of the study population were found having feeling of wrist and hand pain because of smartphone use which may lead to further physiological and physiological complication.

Keywords: Dependency, electromagnetic radiation, mobile phone addiction, smartphone

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INTRODUCTION

Mobile/hand phones are powerful communication devices, first demonstrated by Motorola in 1973, and made commercially available from 1984.[1] In the last few years, hand phones have become an integral part of our lives. The number of mobile cellular subscriptions is constantly increasing every year. In 2016, there were more than seven billion users worldwide. The percentage of internet usage also increased globally 7-fold from 6.5% to 43% between 2000 and 2015. The percentage of households with internet access also increased from 18% in 2005 to 46% in 2015.[2]

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Parlay, the addiction behavior to mobile phone is also increasing. In 2012, new Time Mobility Poll reported that 84% people "couldn't go a single day without their mobile devices."[3] Around 206 published survey reports suggest that 50% of teens and 27% of parents feel that they are addicted to mobiles.[4] The recent studies also reported the increase of mobile phone dependence, and this could increase internet addiction.[5] Overusage of mobile phones may cause psychological illness such as dry eyes, computer vision syndrome, weakness of thumb and wrist, neck pain and rigidity, increased frequency of De Quervain's tenosynovitis, tactile hallucinations, nomophobia,

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insecurity, delusions, auditory sleep disturbances, insomnia, hallucinations, lower self-confidence, and mobile phone addiction disorders.[6] In animals, chronic exposure to Wi-Fi radiation caused behavioral alterations, liver enzyme impairment, pyknotic nucleus, and apoptosis in brain cortex.[7] Kesari *et al.* concluded that the mobile phone radiation may increase the reactive oxygen species, which plays an important role in the development of metabolic and neurodegenerative diseases.[8]

In recent years, most of the global populations (especially college and university students), use smartphones, due to its wide range of applications. While beneficial in numerous ways, smartphones have disadvantages such as reduction in work efficacy, personal attention social nuisance, and psychological addiction. Currently, the addiction to smartphones among students is 24.8%–27.8%, and it is progressively increasing every year.[9] Mobile phone is becoming an integral part to students with regard to managing critical situations and maintaining social relationships.[10] This behavior may reduce thinking capabilities, affect cognitive functions, and induce dependency. The signs of smartphone addiction are constantly checking the phone for no reason, feeling anxious or restless without the phone, waking up in the middle of night to check the mobile and communication updates, delay in professional performance as a result of prolonged phone activities, and distracted with smartphone applications.[11]

Mobile phone is the most dominant portal of information and communication technology. A mental impairment resulting from modern technology has come to the attention of sociologists, psychologists, and scholars of education on mobile addiction.[12] Mobile phone addiction and withdrawal from mobile network may increase anger, tension, depression, irritability, and restlessness which may alter the physiological behavior and reduce work efficacy. Hence, the present study was planned to study the addiction behavior of mobile phone usage using an online survey.

METHODS

This study was approved by Human and Animal Ethics Committee of AIMST University (AUHAEC/FOP/2016/05) and conducted according to the Declaration of Helsinki. The study was conducted among a sample of Malaysian adults. The study participants were invited through personal communications to fill the online survey form. The study was conducted between December 2015 and 2016. The study instrument comprised eight segments, namely, informed consent information, consent acceptance page, demographic details, habituation, mobile phone fact and electromagnetic radiation (EMR) details, mobile phone awareness education, psychomotor (anxious behavior) analysis, and health issues. If any of the participants were not willing to continue in the study, they could decline as per their discretion.

Totally, 450 participants were informed about the study and 409 participated in the study. The demographic details of the study participants are summarized in Table 1. The incomplete forms were excluded from the study. The participants' details were maintained confidentially.

Statistical analysis

Frequency of the data was calculated and the data were analyzed using two-sided Chi-square test with Yate's continuity correction.

RESULTS

Totally, 409 individuals participated in the study, of which 42.3% were males and 57.7% were females, between the age group of 18 and 55 years. Nearly 75.6% of the respondents were between the age group of 21 and 25 years. The mean age of the study participants was 22.88 (standard error = 0.24) years. The study participants' demographic details are summarized in Table 1.

About 95% of the study participants were using smart phones, with 81.7% of them having at least one mobile phone. Most of the study participants used mobile phone for more than 5 years. Around 64.3% of the study participants use mobile phone for an hour (approximately) and remaining use it for more than an hour. Nearly 36.7% of the study participants have the habit of checking mobile phones in between sleep, while 27.1% felt inconvenience with mobile phone use. Majority of the respondents were using mobile phone for communication purposes (87.8%), photo shooting (59.7%), entertainment (58.2%), and educational/academic purposes (43.8%). Habits of mobile phone usage among the study participants are summarized in Table 2.

The study results indicate that 86.8% of the participants are aware about EMR and 82.6% of the study participants are aware about the dangers of EMR. The prolonged use/exposure to EMR may cause De Quervain's syndrome, pain on wrist and hand, and ear discomfort. Among the study participants, 46.2% were having awareness on De Quervain's syndrome, 53.8% were feeling ear discomfort, and 25.9% were having mild-to-moderate wrist/hand pain. Almost 34.5% of the study participants felt pain in the

Table 1: Demographic details of the study participants

Particulars	Number of participants (%)
Number of participants enrolled	450
Number of participants participated	409
Male	173 (42.3)
Female	236 (57.7)
Age group (years)	
<20	60 (14.7)
21-25	309 (75.6)
26-30	17 (4.2)
31-35	9 (2.2)
36-40	6 (1.5)
41-45	3 (0.7)
46-50	2 (0.5)
>51	3 (0.7)
Academic qualification	
Primary school education	1 (0.2)
Secondary school education	74 (18.1)
Graduate (undergraduate degree)	315 (77.0)
Graduate (postgraduate degree)	19 (4.6)
Occupation	
Student	335 (81.9)
Working (graduate)	60 (14.7)
Working (nongraduate)	14 (3.4)
Accommodation	
Home	112 (27.4)
Hostel	297 (72.6)

Table 2: Habituation analysis of mobile phone usage

Habituation	Number of participants (%)
Type of mobile phone usage	
Smartphone	390 (95.4)
Normal/basic phone	2 (0.5)
Both smartphone and normal/basic phone	17 (4.2)
Number of cell phones used by the study participants	
1	334 (81.7)
>1	75 (18.3)
Number of years of mobile phone usage by study participants (years)	
<5	59 (14.4)
6–10	263 (64.3)
10–15	78 (19.1)
15–20	9 (2.2%)
Duration of mobile usage per day (h)	
<1	263 (64.3)
<2	78 (19.1)
<3	55 (13.4)
>3	13 (3.2)
Frequency of mobile phone checking (times)	
0–10	105 (25.7)
11–20	104 (25.4)
21–30	150 (36.7)
>30	50 (12.2)
Checking mobile phone in-between sleep	
Yes	150 (36.7)
No	259 (36.3)
Feeling inconvenience	
Yes	111 (27.1)
No	298 (72.9)
Most frequently used application by study participants (multiple selections)	
Communications	359 (87.8)
Photo	244 (59.7)
Entertainments	238 (58.2)
Media	236 (57.7)
Education	179 (43.8)
Game	154 (37.7)
Sports	74 (18.1)
Reading news and books	4 (1.0)
Reminder and calendar	1 (0.2)

wrist or at the back of the neck while utilizing smartphones [Table 3a]. Many of the study participants also agreed that mobile phone usage causes fatigue (12% agreed; 67.5% strongly agreed), sleep disturbance (16.9% agreed; 57.7% strongly agreed), and psychological disturbance (10.8% agreed; 54.8% strongly agreed) [Table 3b]. The study participants were having level 6 of awareness on mobile phone usage and EMR.

The behavioral analysis of the smartphone usage revealed that 70.4% of the study participants use smartphone longer than intended and 66.5% of the study participants are engaged for longer duration with smartphone. Nearly 57.7% of the study participants exercise control using their phones only for specific important functions. More number of study participants (58.2%) felt uncomfortable without mobile and were not able to withstand not having a smartphone, feeling discomfort with running out of battery (73.8%), felt anxious if not browsing through their favorite smartphone application (41.1%), and 50.4% of the study participants declared that they would never quit using smartphones even though their daily lifestyles were being affected by it. The study also revealed another important finding that 74.3% of smartphone users are feeling dependency on the use of smartphone. The addiction behavior analysis data of mobile phone are summarized in Table 4.

The study results also suggest that female participants were having more awareness than male participants ($P < 0.001$) [Table 5a] and were more dependent on smartphones than male participants ($P < 0.05$) [Table 5b]. Female participants were ready to quit using smartphones, if it affected daily lifestyle compared with male participants ($P < 0.05$) [Table 5b]. Habituation of mobile phone use and addiction behavior were compared between both genders of the study participants and are summarized in Table 5a and b, respectively.

A total of 297 participants were having accommodation in hostel, among them 39.6% of the study participants checked their mobile phone on an average of 21–30 times, a day, and 11.7% of the study participants checked their mobile phone more than 30 times a day. A total of 112 participants have accommodation in home, among them

28.6% of the study participants checked their mobile phone 21–30 times a day, and 13.4% of the study participants checked their mobile phone more than 30 times a day.

A total of 66.1% of participants having accommodation in home use their phones longer than intended, whereas 71.8% of participants having accommodation in hostel are using phone longer than intended. Forty-one (36.6%) and 109 (36.6%) participants from home and hotel checked mobile phone in-between sleep, respectively. About 67.9% of participants having accommodation in home felt dependent on mobile and it was the same for participants having accommodation in hostel (76.5%).

DISCUSSION

The study results suggest that a significant number of the participants had addiction to mobile phone usage, but were not aware on it, as mobile phones have become an integral part of life. No significant differences were found on addiction behavior between the participants residing in hostel and homes.

Table 3a: Analysis of awareness of mobile phone hazards

Particulars	Number of participants (%)
Place of hand phone keeping	
In the bag	152 (37.2)
Around pelvic area	250 (61.1)
Around your neck	7 (1.7)
Awareness about EMR	
Yes	355 (86.8)
No	54 (13.2)
Awareness on danger of EMR	
Yes	338 (82.6)
No	71 (17.4)
Awareness on De Quervain's syndrome/texting thumb	
Yes	189 (46.2)
No	50 (12.2)
No idea	170 (41.6)
Feeling of any ear discomfort while using mobile phone	
Yes	220 (53.8)
No	359 (87.8)
Having any pain on wrist and hand because of smartphone use	
Yes	106 (25.9)
No	303 (74.1)
Feeling torment/pain in the wrists or at the back of the neck while utilizing a smartphone	
Yes	141 (34.5)
No	268 (65.5)

EMR: Electromagnetic radiation

Mobile phone abuse is rising as an important issue among the world population including physical problems such as eye problems, muscular pain, and psychological problem such as tactile and auditory delusions.[13] Along with mobile phone, availability of Wi-Fi facility in residence place and work premises also increases mobile phone dependence. The continuous and constant usage of mobile phone reduces intellectual capabilities and work efficacy. A study conducted in Chinese population (160 million out of the total 1.3 billion people) showed that people affected by mobile phone dependence have difficulty in focusing on work and are unsociable, eccentric, and use phones in spite of facing hazards or having knowledge of harmful effects of this form of electromagnetic pollution.[14]

The statement "I will never quit using my smartphone even though my daily lifestyles are affected by it" was statistically significant ($P = 0.0229$). This points to a trend of mobile phone addiction among the respondents. This finding was discussed by Salehan and Negahban. They stated that this trend is due to the fast growth in the use of online social networking services (SNS). Extensive use of technology can lead to addiction. The use of SNS mobile applications is a significant predictor of mobile addiction. Their result showed that the use of SNS mobile applications is affected by both SNS network size and SNS intensity of the user. It has implications for academia as well as governmental and non-for-profit organizations regarding the effect of mobile phones on individual's and public health.[15] The health risks associated with mobile phones include increased chances of low self-esteem, anxiety or depression, bullying, eye strain and "digital or mobile phone thumb," motor vehicle accidents, nosocomial infections, lack of sleep, brain tumors and low sperm counts, headache, hearing loss, expense, and dishonesty. The prevalence of cell phone dependence is unknown, but it is prevalent in all cultures and societies and is rapidly rising.[16] Relapse rate with mobile phone addiction is also high, which may also increase the health risk and affect cognitive function. Sahin *et al*. studied mobile phone addiction level and sleep quality in 576 university students and found that sleep quality worsens with increasing addiction level.[17]

The statement "Feeling dependent on the use of smartphone" was also statistically significant ($P = 0.0373$). This was also

Table 3b: Analysis of awareness of mobile phone hazards

Particulars	Strongly agree (%)	Agree (%)	Disagree (%)	Strongly disagree (%)
Thinking that mobile phone usage causing fatigue	49 (12.0)	276 (67.5)	74 (18.1)	10 (2.4)
Thinking that cell phone usage causing sleep disturbance	69 (16.9)	236 (57.7)	87 (21.3)	17 (4.1)
Thinking that cell phone usage causing Gastrointestinal trac disturbance	8 (2)	119 (29.1)	241 (58.9)	41 (10.0)
Thinking that cell phone usage causing mental/psychological disturbance	44 (10.8)	224 (54.8)	120 (29.3)	21 (5.1)

GIT: Gastrointestinal tract

explored by Richard *et al.* among 404 university students regarding their addiction to smartphones. Half of the respondents were overtly addicted to their phones, while one in five rated themselves totally dependent on their smartphones. Interestingly, higher number of participants felt more secure with their phones than without. Using their phones as an escapism was reported by more than half of the respondents.

Table 4: Addiction behavior analysis of mobile phone

Particulars	Number of participants (%)	
	Yes	No
Awareness on time spend in smartphone	249 (60.88)	160 (39.12)
Utilization of smartphone longer than intended	288 (70.4)	121 (29.6)
Finding too much of time are engaged with smartphone	272 (66.5)	137 (33.5)
Having control on using phone on specific objectives	236 (57.7)	173 (42.3)
Missing planned work because of smartphone use	150 (36.7)	259 (63.3)
Feeling of missing normal social life using smartphone	114 (27.9)	296 (72.1)
Experiencing difficulties in regular day-to-day life (such as problems in completing job assignments)	129 (31.5)	280 (68.5)
Won't be able to withstand of not having a smartphone	238 (58.2)	171 (41.8)
Feeling impatient and fretful when not conserving smartphone	196 (47.9)	213 (52.1)
Having my smartphone in my mind even when i am not using it	120 (29.3)	289 (70.7)
Feeling discomfort when your smartphone is running out of battery	302 (73.8)	107 (26.2)
Feeling anxious if you not check your favorite smartphone application	168 (41.1)	241 (58.9)
I will never quit using my smartphone even though my daily lifestyles are affected by it	206 (50.4)	203 (49.6)
Feeling dependent on the use of smartphone	304 (74.3)	105 (25.7)
Having any health issues due to use of smartphone	60 (14.7)	349 (85.3)

This study revealed an important fact that people are not actually addicted to their smartphones *per se;* however, it is to the entertainment, information, and personal connections that majority of the respondents were addicted to.[18]

The 2015 statistical report from the British Chiropractic Association concluded that 45% of young people aged 16–24 years suffered with back pain. Long-term usage of smart phone may also cause incurable occipital neuralgia, anxiety and depression, nomophobia, stress, eyesight problem, hearing problems, and many other health issues.[19]

A study conducted among university students of Shahrekord, Iran, revealed that 21.49% of the participants were addicted to mobile phones, 17.30% participants had depressive disorder, 14.20% participants had obsessive-compulsive disorder, and 13.80% had interpersonal sensitivity.[12] Nearly 72% of South Korean children aged 11–12 years spend 5.4 h a day on mobile phones, 25% of those children were considered addicts to smartphones.[20] Thomée *et al.* collected data from 4156 adults aged between 20 and 24 years and observed no clear association between availability demands or being awakened at night and the mental health outcomes.[21] Overuse of mobile phone can lead to reduced quality of interpersonal relationships and lack of productivity in daily life. The study outcome from different studies showed variable results on addictive behavior on mobile phone usage. The fact is over-/long-time usage of mobile phone may cause behavioral alteration and induce addictive behavior.

CONCLUSION

This study suggests that most of the study participants are aware about mobile phone/radiation hazards and many of them developed dependent behavior

Table 5a: Comparison of habituation of mobile phone usage between genders

Particulars	Response	Male (%)	Female (%)	Level of significance
Checking mobile phone in-between sleep	Yes	69 (39.9)	81 (34.3)	0.2940
	No	104 (60.1)	155 (65.7)	
Feeling inconvenience	Yes	53 (30.6)	58 (24.6)	0.2117
	No	120 (69.4)	178 (75.4)	
Awareness about EMR	Yes	140 (80.9)	215 (91.5)	0.0043
	No	33 (19.1)	20 (8.5)	
Awareness on the danger of EMR	Yes	140 (80.9)	198 (83.9)	0.5143
	No	33 (19.1)	38 (16.1)	
Awareness on De Quervain's syndrome/texting thumb	Yes	80 (46.2)	109 (46.2)	0.9910
	No	93 (53.8)	127 (53.8)	
Feeling of any ear discomfort while using mobile phone	Yes	23 (13.3)	27 (11.4)	0.6798
	No	150 (86.7)	209 (88.6)	
Having any pain on wrist and hand because of smartphone use	Yes	45 (26.0)	61 (25.8)	0.9702
	No	128 (74.0)	175 (74.2)	
Feeling torment/pain in the wrists or at the back of the neck while utilizing a smartphone	Yes	61 (35.3)	80 (33.9)	0.8564
	No	112 (64.7)	156 (66.1)	

All the values are numbers of responses, The data were analyzed using two-sided Chi-square test with Yate's continuity correction.
EMR: Electromagnetic radiation

Table 5b: Comparison of addiction behavior between genders

Particulars	Response	Male (%)	Female (%)	Level of significance
Awareness on time spend in smartphone	Yes No	101 72	148 88	0.4330
Utilization of smartphone longer than intended	Yes No	122 (70.5) 51 (29.5)	166 (70.3) 70 (29.7)	0.9684
Finding too much of time are engaged with smartphone	Yes No	108 (62.4) 65 (37.6)	164 (69.5) 72 (30.5)	0.1647
Having control on using phone on specific objectives	Yes No	99 (57.2) 74 (42.8)	137 (58.1) 99 (41.9)	0.9477
Missing planned work because of smartphone use	Yes No	56 (32.4) 117 (67.6)	94 (39.8) 142 (60.2)	0.1491
Feeling of missing normal social life using smartphone	Yes No	48 (27.7) 125 (72.3)	66 (28.0) 170 (72.0)	0.9608
Experiencing difficulties in regular day-to-day life	Yes No	56 (32.4) 117 (67.6)	73 (30.9) 163 (69.1)	0.8404
Won't be able to withstand of not having a smartphone	Yes No	101 (58.4) 72 (41.6)	137 (58.1) 99 (41.9)	0.9466
Feeling impatient and fretful when not conserving smartphone	Yes No	89 (51.4) 84 (48.6)	107 (45.3) 129 (54.7)	0.2623
Having my smartphone in my mind even when I am not using it	Yes No	57 (32.9) 116 (67.1)	63 (26.7) 173 (73.3)	0.2069
Feeling discomfort when your smartphone is running out of battery	Yes No	125 (72.3) 48 (27.7)	177 (75.0) 59 (25.0)	0.2069
Feeling anxious if you not check your favorite smartphone application	Yes No	79 (45.7) 94 (54.3)	89 (37.7) 147 (62.3)	0.1302
I will never quit using my smartphone even though my daily lifestyles are affected by it	Yes No	99 (57.2) 74 (42.8)	107 (45.3) 129 (54.7)	0.0229
Feeling dependent on the use of smartphone	Yes No	119 (68.8) 54 (31.2)	185 (78.4) 51 (21.6)	0.0373
Having any health issues due to the use of smartphone	Yes No	28 (16.2) 145 (83.8)	32 (13.6) 204 (86.4)	0.5485

All the values are numbers of responses. The data were analyzed using two-sided Chi-square test with Yate's continuity correction

with smartphone. No significant changes were found on mobile phone dependency behavior between participants having accommodation in house and hostel. One-fourth of the study population is having a feeling of wrist and hand because of smartphone usage which may lead to further physiological and physiological complications.

Limitations

- Cluster sampling from a wider population base could have provided a more clear idea regarding the topic of interest
- Increasing the time frame and number of study phases was not possible due to logistical issues
- Impact of smartphone addiction on sleep pattern could have been studied in-depth.

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Conflicts of interest

There are no conflicts of interest.

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