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A Cross Sectional Study on the Effects of Smartphone Usage on Neurological Symptoms Among Undergraduate Students of Melaka-Manipal Medical College

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Abstract

With the increased use of mobile phones, the risk they pose to health and quality of life has increased considerably. Therefore, in this study we are trying to explore about the association of smartphone radiation with neurological symptoms such as visual defects, sleep disturbance, headache and stress. This cross-sectional study was conducted in Melaka-Manipal Medical College, from December 2017 to January 2018. Prepared questionnaires were distributed to students. The questionnaire was in line with the objective of the study includes socio-demographic attributes of the students, the brands and models of the smartphones, the average hours students spent on smartphones per day, purpose of using the smartphone, several factors that believed to be associated with the smartphone use, questions on the Migraine Disability Assessment (MIDAS) score, Pittsburgh Sleep Quality Index (PSQI) and Perceived Stress Scale (PSS). Linear regression and logistic regression analysis was conducted using the Epi-Info 7 version 7.2.0.1. software. We had 223 completed questionnaires from the undergraduate students. There were significant positive association seen between usage of smartphone in the dark and tingling sensation. Those who used smartphones in the dark are 1.88 times more likely to get tingling sensations. Among all the vision problems, only dry eyes was found not to be having any significant with all the variables. As for the sleep disturbance, brightness of screen, hours spend per day and usage in dark had a significant relation with is. Moreover, positive significant association were seen between stress and radiation, screen brightness and duration of smartphone usage. Based on the result of the present study, we conclude that smartphone radiation and duration spend on smartphone has association with neurological symptoms such as tingling, vision problems, sleep disturbances, headache and stress level. Ultimately there is a positive association seen between the independent and dependent variables.

Keywords

Smartphone, Radiation, Students

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1. Introduction

We being a generation witnessing the Technological revolution right in front of our eyes, it is important to bring the adverse effects of technology into the current conversation rather than being blinded by the fact that technology makes or life easy. Therefore, in this study we are trying to explore about the association of smartphone radiation with neurological symptoms such as visual defects, sleep disturbance, headache and stress.

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With the increased use of mobile phones, the risk they pose to health and quality of life has increased considerably [1]. An average person spends about 2 hours and 57 minutes on their smartphone each day according to a study conducted by a digital analytics firm known as Flurry. [2] A previous research concludes that 84.3% of its subjects admitted having some knowledge of the harmful effects of mobile phones on human health. [3] It is alarming to see that even with the knowledge of possibility of harmful effects of smartphone radiation, its popularity keeps increasing day by day.

WHO/International Agency for Research on Cancer (IARC) has conducted research on the potential carcinogenic hazards from exposure to radiofrequency electromagnetic fields showing a result of a 40% increased risk for gliomas in the highest category of heavy users (reported average: 30 minutes per day over a 10-year period). [4]

In a cohort study for long term subscribers of mobile phones it was revealed to have a weak positive association with migraine and vertigo but inverse associations with Alzheimer disease, vascular and other dementia, Parkinson disease and epilepsy among men but no associations were seen with ALS, multiple sclerosis or epilepsy among women. [5] Nevertheless, a further study done on the acute symptoms due to smartphone usage shows that sensations of warmth on the ear or behind or around the ear were experienced mainly during and shortly after phone calls were made and Headaches typically appeared during or within 30 min after the call, and for most people this symptom continued up to 2 or 6 hours after the call, but in some cases, it lasted for more than 6 hours. [6]

In addition to these symptoms, it has been found that the Computer Vision Syndrome, which cause blurring of vision and straining due to eyes becoming fatigued and our facial, neck and shoulder muscles tighten as we squint to read these miniature screens, is also seen among the smartphone users.

At least 1 out of every 4 eye patients complains about eye strain due to reading text on a small screen says Jeff Taylor, M. D., Medical Director for YourSightMatters.com. He also says that we normally about 15 times per minute, but this rate decreases by half when we are staring at our smartphone. [7]

Due to the significant stress from the elbows to the fingers when holding the smartphone causes numbness and tingling sensation in the user. [8] Furthermore, it has been found that early wear, tear, degeneration, and possibly spinal surgeries can be resulted due to long term incorrect posture. When flexing the head at varying degrees while using the smartphones, the loss of the natural curve of the cervical spine leads to incrementally increased stresses about the cervical spine can be seen and will lead spinal surgeries. [9]

Not only physical manifestations but also mental health also could be affected due to the smartphones. Smartphone addiction which is rapidly spreading around the world has may have resulted in many types of mental ill health. Symptoms of Anxiety and Depression can be seen among the smartphone subscribers since it has become a social standard to be an owner of a smartphone and the social acceptance that comes with it. [10]

“Constant checker” are the ones who check their email, texts and social media accounts on a constant basis. American Psychological Association’s Stress has done a survey which found that stress runs higher, on average, for constant checkers than for those who do not engage with technology as frequently. [11]

Furthermore, Smartphones cause sleep disturbances. According to a study conducted on Direct Measurements of Smartphone Screen-Time: Relationships with Demographics and Sleep it has been revealed that there is a significant decrease in the sleep efficiency, poor sleep quality, and longer sleep onset latency. [12] Insomnia can be seen in the smartphone users because sleep deprivation is magnified by exposure to a kind of blue light emitted by the devices which tricks the body into being kept awake by suppressing melatonin. [13]

Most people now check their smartphones 150 times per day, or every six minutes, young adults are now sending an average of 110 texts per day. 46 percent of smartphone users now say that their devices are something they ‘couldn’t live without’. [14] We live in a world where a wide range of models by different smartphone production companies are available, which releases one new model after the next with newer features. According to statistical analysis the number of mobile phone users in the world is expected to pass the five billion mark by 2019. [15] But we should keep in mind that for the sake of our future generations we should hope that the smartphone does not outsmart us.

Our Research objective is to determine the association of smartphone radiation, eye protection mode, brightness level, use in dark, hours spent and years of usage with the neurological symptoms. Our research question is ‘Is the usage of smartphone brings harm to central nervous system?’ Finally, our research hypothesis is the increase in the radiation level, years and hours spend on smartphones will worsen the neurological symptoms.

2. Methodology

The study was conducted from December 2017 to January 2018 as a part of our research project to find out the association of smartphone radiation with neurological

symptoms especially vision problems, headache, sleep quality and stress level. The study is a cross sectional research conducted on the students of Melaka Manipal Medical College (MMMC). A total number of 250 students were expected to contribute in the study, however we could obtain 223 participants, 27 questionnaires were not included in the study as there were answered incomplete. The participants we included in the research consist of students from MBBS batch 36 and Foundation in Science students. The expected frequency of the study is 11.8% [16] with 95% confidence interval with acceptable margin of 5% error we acquired a minimum sample size of 160 (Batch 36 MBBS students and Foundation in Science students) by using software Epi-Info7 version 7.2.0.1.

The inclusion criteria is those MMMC students who had given consent voluntarily. The exclusion criteria are those students who did not respond appropriately to the questionnaire for example those who have answered only a single column of PSQI score.

Before data collection, the students were gathered in their classes and the prepared questionnaires were distributed and completed by the students under our supervision. The questionnaire which was prepared by using the literature in line with the objective of the study includes socio-demographic attributes of the students, the brands and models of the smartphones, the average hours students spent on smartphones per day, purpose of using the smartphone, several factors that believed to be associated with the smartphone use, questions on the Migraine Disability Assessment (MIDAS) score, Pittsburgh Sleep Quality Index (PSQI) and Perceived Stress Scale (PSS). In order for us to explore the usage of smartphone of the participants, we had included the model of their smartphone, years of usage of smartphone and the hour(s) spend on smartphone per day. Purposive sampling was applied in selecting the participants from the above-mentioned population group due to easy accessibility, student's availability and ease of their volunteering.

The smartphone radiation level, independent variable of our study was evaluated by using the Specific Absorption Rate (SAR) whereas specific scales were used to determine the outcomes. The MIDAS Questionnaire was developed to assess headache-related disability with the aim of improving migraine care. It consists of five questions, scoring the number of days, in the past 3 months, of activity limitations due to migraine. For the sleep quality assessment, the PSQI was used and it has 24 items. Overall, 0-3 points are given for each question. The scores to be obtained in the scale vary between 0 to 21, higher score denote to poorer sleep quality. The PSS is a classic stress assessment instrument and the questions in the scale ask about your feelings and thoughts during the last month. Individual scores on the PSS can range from 0 to 40 with higher scores indicating higher perceived stress.

Data were recorded and analysed using Epi-Info7 version 7.2.0.1. As our study involved 1 independent variable and 4 dependent variables, the results were calculated differently and matched with the smart phone radiation. We explored the association between the duration of using smartphone, hours spent on smartphone per day, brightness of the smartphone, eye protection, usage of smartphone in the dark and the neurological symptoms. We able to analyse both the descriptive and inferential statistics independently. We have calculated the frequency and percentage of each components of questionnaire. The mean and standard deviation was obtained for age and PSQI score. As for the inferential statistic the variables were initially classified, and linear regression and logistic regression were performed to find the association between smartphone usage and neurological symptoms. Linear regression was used for PSQI and stress level while the logistic regression was used for visual problems and MIDAS score assessment. ORs were reported with the corresponding 95% confidence intervals and the level of significance was set at 95%(p value <0.05).

All participants gave written informed consent to be part of the study and their confidentiality was assured to the students. Approval to conduct the study was obtained from Melaka Manipal Medical College Research Committee, Melaka Manipal Medical College, Melaka, Malaysia.

3. Results

We had send out 250 copies of questionnaires and we had gotten back all the questionnaires. But, only 223 were being filled completely (respond rate=89.20%). The study group consisted of 223 students, where 78(34.98%) were male and 145(65.02%) were female. Their age varied from 16 to 30 with an average age of 21.56 ± 1.89 years. We obtained 40.36% of Indians, 39.01% of Chinese, 13.90% of Malay and 6.73% of other races.

The purposes of the students using smartphone were texting (90.58%), social (90.13%), entertainment (89.69%), calling (82.51%) and education (80.27%).

The prevalence of tingling, vision problems, headache (Migraine Disability Assessment/MIDAS score), sleep disturbance (Pittsburgh Sleep Quality Index/PSQI score), stress (Perceived Stress Scale/PSS) have been tabulated into Table 1.

Table 1. Prevalence of tingling, vision problems, headache (MIDAS score), sleep disturbance (PSQI score), stress (Perceived Stress Scale).

Variables	n (%)
Tingling:	
Yes	81 (36.62)
No	142 (63.68)
Vision problems:	
Short-sightedness:	
Yes	121 (54.26)
No	102 (45.74)
Long-sightedness:	
Yes	28 (12.56)
No	195 (87.44)
Eye strain:	
Yes	51 (22.87)
No	172 (77.13)
Dry eyes:	
Yes	23 (10.31)
No	200 (89.69)
Blurred vision:	
Yes	34 (15.25)
No	189 (84.75)
Headache (MIDAS):	
Grade 1	186 (83.41)
Grade 2	15 (6.73)
Grade 3	13 (5.83)
Grade 4	9 (4.04)
Mean (SD)	3.33 (7.73)
Sleep disturbance (PSQI):	
Mean (SD)	6.08 (3.17)
Stress (Perceived Stress Scale):	
Low	17 (7.62)
Moderate	187 (83.86)
High	19 (8.52)
Mean (SD)	19.91 (4.52)

For tingling and vision problems, we interpreted the data by using multiple logistic regression, whereas for headache (MIDAS score), sleep disturbance (PSQI score) and stress (Perceived Stress Scale), we used multiple linear regression to analyse the data.

There was only one variable which has positive significant associated with tingling, which is the usage of smartphone in the dark (P=0.047) (Table 2). From the result, we can see that those who used smartphones in the dark are 1.88 times more likely to get tingling sensations compared to those who do not have the habit of using it in the dark. Other variables like radiation, brightness of the screen, eye protection mode, years of usage and hours spend per day had no significant on the tingling sensation.

Table 2. Multiple logistic regression results for tingling.

Variables	Tingling		Odd Ratio	P Value
	Yes	No		
Radiation (W/kg)			1.06 (0.48,2.34)	0.888
Brightness:				
Low	39(48.15)	60(42.25)	0.52 (0.17,1.59)	0.253
Medium	38(46.91)	73(51.41)	0.40 (0.13,1.27)	0.122
High	4(4.94)	9(6.34)	-reference-	
Eye Protection:				
With	48(59.26)	96(67.61)	0.64 (0.33,1.23)	0.181
Without	33(40.74)	46(32.39)	-reference-	
Years of usage			1.00 (0.92,1.09)	0.963
Hours spend per day			1.02 (0.95,1.09)	0.608
Use in dark:				
Yes	55(67.90)	74(52.11)	1.88 (1.01,3.51)	0.047
No	26(32.10)	68(47.89)	-reference-	

Among all the vision problems, only dry eyes was found not to be having any significant with all the variables (Table 3).

Table 3. Multiple logistic regression results for dry eyes.

Variables	Vision – Dry Eyes		Odd Ratio	P Value
	Yes	No		
Radiation (W/kg)			0.44 (0.13,1.46)	0.178
Brightness:				
Low	10(43.48)	89(44.50)	1.76 (0.32,9.75)	0.516
Medium	11(47.83)	100(50.00)	1.52 (0.25,9.16)	0.649
High	2(8.70)	11(5.50)	-reference-	
Eye Protection:				
With	12(52.17)	132(66.00)	0.43 (0.16,1.16)	0.095
Without	11(47.83)	68(34.00)	-reference-	
Years of usage			0.94 (0.82,1.09)	0.429
Hours spend per day			0.90 (0.78,1.04)	0.154
Use in dark:				
Yes	12(52.17)	117(58.50)	0.66 (0.25,1.71)	0.388
No	11(47.83)	83(41.50)	-reference-	

As for short-sightedness, the time spend on smartphone had a significant effect on it. Years of smartphone usage had a P value of 0.027, where those who had spent more years of using smartphone will have 1.11 more chances of getting short-sightedness; while hours spend per day on smartphone had a P value of 0.012, where those who had spent more hours daily on using smartphone will have 0.91 more chances of getting short-sightedness. Radiation, brightness of screen, eye protection mode and use of smartphone in the dark had no significant on short-sightedness (Table 4).

Table 4. Multiple logistic regression results for short sightedness.

Variables	Vision – Short Sightedness		Odd Ratio	P Value
	Yes	No		
Radiation (W/kg)			0.67 (0.30,1.46)	0.312
Brightness:				
Low	53(43.80)	46(46.46)	1.70 (0.55,5.23)	0.354
Medium	63(52.07)	48(47.06)	1.89 (0.59,5.98)	0.282
High	5(4.13)	8(7.84)	-reference-	
Eye Protection:				
With	77(63.64)	67(65.69)	1.00 (0.52,1.91)	0.997
Without	44(36.36)	35(34.31)	-reference-	
Years of usage			1.11 (1.01,1.21)	0.027
Hours spend per day			0.91 (0.84,0.98)	0.012
Use in dark:				
Yes	70(57.85)	59(57.84)	1.04 (0.57,1.91)	0.899
No	51(42.15)	43(42.16)	-reference-	

As shown in Table 5, only radiation level had significant on long-sightedness (P=0.004), where it indicates that those with higher smartphone radiation had 0.21 times higher of getting long-sightedness. Meanwhile, brightness of the screen, eye protection mode, years of usage, hours spend per day and usage of phone in the dark had not shown any significant.

Table 5. Multiple logistic regression results for long sightedness.

Variables	Vision – Long Sightedness		Odd Ratio	P Value
	Yes	No		
Radiation (W/kg)			0.21 (0.07,0.60)	0.004
Brightness:				
Low	13(46.43)	86(44.10)	0.27 (0.06,1.20)	0.087
Medium	12(42.86)	99(50.77)	0.29 (0.06,1.29)	0.104
High	3(10.71)	10(5.13)	-reference-	
Eye Protection:				
With	22(78.57)	122(62.56)	1.86 (0.64,5.44)	0.255
Without	6(21.43)	73(37.44)	-reference-	
Years of usage			0.99 (0.86,1.14)	0.903
Hours spend per day			1.08 (0.98,1.20)	0.102
Use in dark:				
Yes	17(60.71)	112(57.44)	1.00 (0.40,2.51)	0.999
No	11(39.29)	83(42.56)	-reference-	

Coming to the next vision problem which is eye strain, brightness of the screen had a significant, but only when low brightness is compared to high brightness (P=0.010), not medium brightness compared to high brightness (P=0.060). Those who used their smartphone with high brightness had more 0.20 chances of getting eyestrain compared to those with low screen brightness. Radiation, eye protection mode, years of usage, hours spend per day and usage in the dark had no significant P values (Table 6).

Table 6. Multiple logistic regression results for eye strain.

Variables	Vision – Eye Strain		Odd Ratio	P Value
	Yes	No		
Radiation (W/kg)			0.84 (0.36,1.96)	0.680
Brightness:				
Low	18(35.29)	81(47.09)	0.20 (0.06,0.68)	0.010
Medium	29(56.86)	82(47.67)	0.31 (0.09,1.05)	0.060
High	4(7.84)	9(5.23)	-reference-	
Eye Protection:				
With	35(68.63)	109(63.37)	1.42 (0.66,3.06)	0.368
Without	16(31.37)	63(36.63)	-reference-	
Years of usage			0.98 (0.89,1.08)	0.677
Hours spend per day			1.03 (0.95,1.12)	0.454
Use in dark:				
Yes	31(60.78)	98(56.98)	1.12 (0.56,2.25)	0.743
No	20(39.22)	74(43.02)	-reference-	

Table 7 had shown that radiation, eye protection mode, hours spend per day and usage of smartphone in the dark had no significant on causing blur vision. Users with high brightness of the screen had 0.23 more chances of causing blur vision compared to both low brightness (P=0.025) and medium brightness (P=0.021). Whereas those users who had more years of using smartphones had 1.14 times higher of having blur vision (P=0.015).

Table 7. Multiple logistic regression results for blur vision.

Variables	Vision – Blur Vision		Odd Ratio	P Value
	Yes	No		
Radiation (W/kg)			0.40 (0.16,1.03)	0.058
Brightness:				
Low	15(44.12)	84(44.44)	0.23 (0.07,0.83)	0.025
Medium	16(47.06)	95(50.26)	0.23 (0.06.0.80)	0.021
High	3(8.82)	10(5.29)	-reference-	
Eye Protection:				
With	22(64.71)	122(64.55)	0.95 (0.41,2.20)	0.904
Without	12(35.29)	67(35.45)	-reference-	
Years of usage			1.14 (1.03,1.27)	0.015
Hours spend per day			1.04 (0.95,1.13)	0.379
Use in dark:				
Yes	19(55.88)	110(58.20)	0.74 (0.34,1.62)	0.448
No	15(44.12)	79(41.80)	-reference-	

For the MIDAS scores, there was no significant P value for all the variables (Table 8). The scatter plot shows that MIDAS score had only little positive correlation, with no significant with the radiation level (Figure 1) (r=0.116, P=0.084).

Table 8. Multiple linear regression results for headache (MIDAS Score).

Variables	Headache/MIDAS Score Adjusted b (95% CI)	P Value
Radiation (W/kg)	2.69 (-0.38, 5.77)	0.086
Brightness:		
Low	-0.28 (-4.64,4.08)	0.898
Medium	-2.93 (-2.93,-7.39)	0.195
High	-reference-	
Eye Protection:	-1.03 (-3.57,1.51)	0.426
Years of usage	0.18 (-0.15,0.51)	0.280
Hours spend per day	0.11 (-0.17,0.39)	0.437
Use in dark	1.55 (-0.82,3.92)	0.198

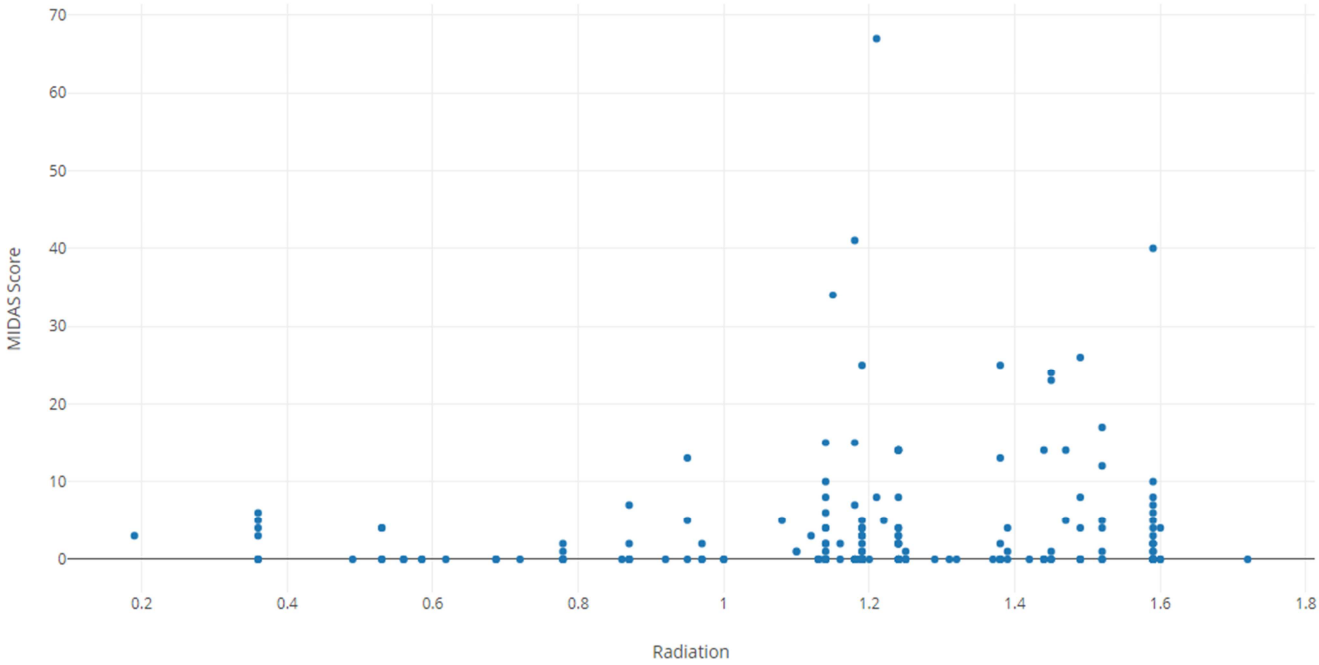

Figure 1. Association between MIDAS score and radiation (r=0.116, P=0.084).

The scores obtained from the PSQI show a positive for screen brightness (P=0.001), hours spend per day (P=0.028) and usage of smartphone in dark (P=0.025) (Table 9). When the low brightness users changed their habit to high brightness, there will be 3.82 marks increase in the PSQI score, and when the medium brightness users changed their habit to high brightness, there will be 3.00 marks increase in the PSQI score. An increase in the hours spend per day on smartphone will cause on increment of 0.12 PSQI marks. When the users had the habit of using smartphone in the dark, the PSQI marks will increased by 1.07 marks. There was only a little negative correlation between PSQI score and radiation without any significant P value (Figure 2) (r= -0.0184, P=0.431).

Table 9. Multiple linear regression results for sleep disturbance (PSQI Score).

Variables	Sleep disturbance (PSQI Score) Adjusted b (95% CI)	P Value
Radiation (W/kg)	0.91 (-0.30,2.12)	0.138
Brightness		
Low	3.82 (2.11,5.53)	0.001
Medium	3.00 (1.25,4.75)	0.001
High	-reference-	
Eye Protection	-0.22 (-1.22,0.77)	0.656
Years of usage	0.06 (-0.06,0.20)	0.309
Hours spend per day	0.12 (0.01,0.23)	0.028
Use in dark	1.07 (0.14,2.00)	0.025

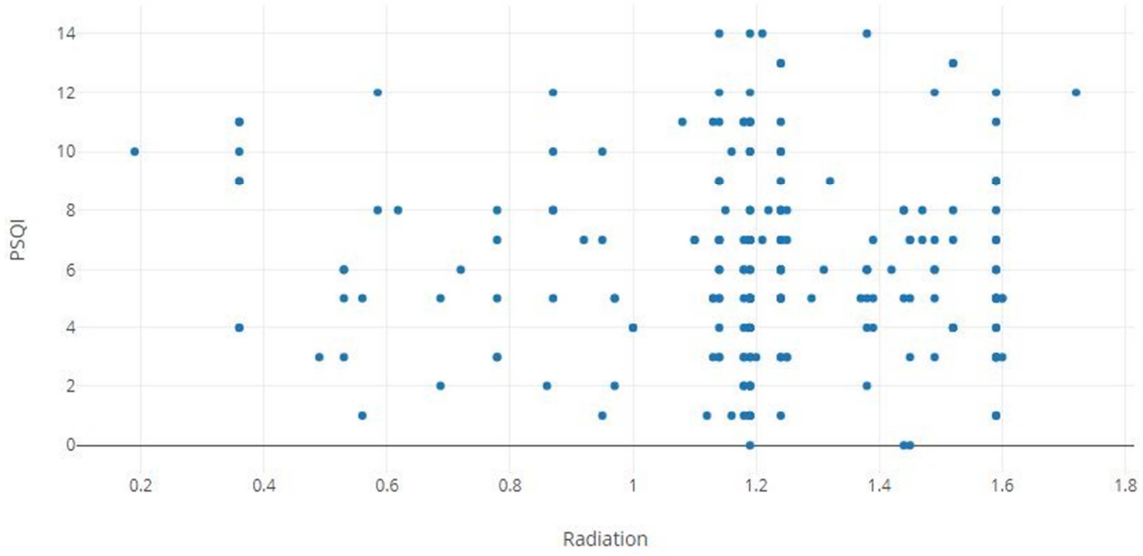

Figure 2. Association between PSQI score and radiation (r= -0.0184, P=0.431).

As for the Perceived Stress Scale, we had found 4 variables having positive correlations with it (Table 10). The first variable is the hour spend per day, which is having P value of 0.048, where when the PSS score will increase by 0.19 when the hours spend per day increases. The P value for years of smartphone usage was 0.010, and there will be an increase of 0.29 marks when there is an increase in the years of usage. The following variables are radiation and brightness with the same P value of 0.001. There will be an increment of 6.48 mark on PSS when the radiation level of smartphone increases. Whereas those high screen brightness users will have an increase of 9.55 and 8.45 PSS score when compared to low brightness and medium brightness respectively. The distribution of scores obtained from Perceived Stress Scale and radiation shows a little positive correlation with no significant. (Figure 3) (r= 0.0334, P=0.620).

Table 10. Multiple linear regression results for Stress score (Perceived Stress Score).

Variables	Stress score (Perceived Stress Scale) Adjusted b (95% CI)	P Value
Radiation (W/kg)	6.48 (4.41,8.55)	0.001
Brightness:		
Low	9.55 (6.62,12.48)	0.001
Medium	8.46 (5.47,11.46)	0.001
High	-reference-	
Eye Protection	-0.18 (-1.90,1.52)	0.832
Years of usage	0.29 (0.07,0.52)	0.010
Hours spend per day	0.19 (0.00,0.38)	0.048
Use in dark	1.35 (-0.24,2.95)	0.096

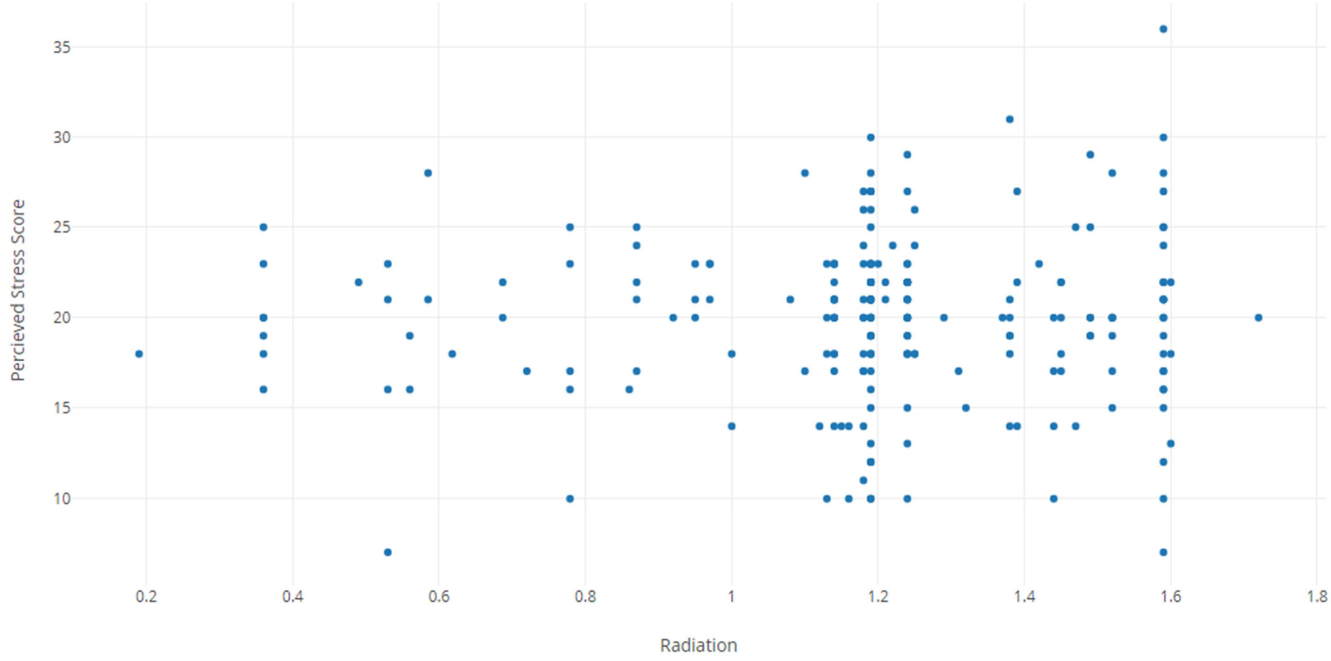

Figure 3. Association between Perceived Stress Score and radiation (r= 0.0334, P=0.620).

4. Discussion

In this research study, we found that out of 250 students only 223 students had completed the questionnaire, and it was consisted of 145 females (65.02%) and 78 males (34.98%). The questionnaires were responded mainly by Indians (40.36%), followed by Chinese (39.01%), Malay (13.90%) and others (6.73%). It was found that majority of the students used smartphones for texting (90.58%) and social (90.13%).

The main findings of our study were tingling, vision problems, headache, sleep disturbance and stress level. There were significant positive association seen between usage of smartphone in the dark and tingling sensation. However, the cause is not clear as there were no any previous studies done to prove this result.

As for the vision problems, there were:

a) Positive significant association were seen between years of usage on smartphone and short sightedness.

b) Positive significant association were seen between hours spend per day on smartphone and short sightedness.

c) Positive significant association were seen between radiation and long sightedness.

d) Positive significant association were seen between low to high brightness and eye strain.

e) Positive significant association were seen between medium to high brightness and blur vision.

f) Positive significant association were seen between years of usage on smartphone and blur vision.

g) Only dry eyes have showed no significant association with all the independent variables.

Based on the other previous studies, it was stated that overuse of smartphone over a long period of time may potentially cause damage to the eyes. [28] Smartphones are portable device and the screens are much smaller, therefore, these habits threaten our vision. Our eye will become strain, itchy, dry, blurry, muscle fatigue and neck or shoulder pain. This series of symptoms is known as Computer Vision Syndrome. [17] [25]

As for headache (MIDAS score), there were no significant P values found for all the variables. However, there was a little positive correlation were seen with radiation.

Positive associations with sleep disturbance (PSQI score) were seen for screen brightness, hours spend per day and usage of smartphone in dark. However, there was only a little negative correlation between PSQI score and radiation without any significant P value. Smartphones will emit something called blue light, [27] [29] it is a type of light interpret as daylight by the brain and it will suppress melatonin (a hormone that affects circadian rhythm) [24] So our brain feels stimulated and sleep pattern will be disturbed. [18]

As for the Perceived Stress Scale (PSS), we had found 4 variables having positive correlations with it:

a) Positive significant association were seen between radiation and PSS.

b) Positive significant association were seen between brightness and PSS.

c) Positive significant association were seen between years of usage of smartphone and PSS.

d) Positive significant association were seen between hours spend per day on smartphone and PSS.

A new research study published in Psychology of Popular Media Culture (takes a look at how text messaging is linked to interpersonal stress in college students and also examined the overall impact of text messaging on health and well-being. [26] he very act of text messaging can magnify the effects of interpersonal stress because of the time and energy involved in a non-stop social environment. This leads to a greater cognitive and attentional load. [19] In addition, too much of smartphone addiction may even lead to worsening symptoms like anxiety and depression. [30]

From our studies, it shows that there's a difference in our results from the previous research because of some limitations such as limited sample size since batch 35 and 33 were having their finals. Apart from that, it is also prone to bias due to low response and misclassification due to recall bias as it is a cross-sectional study, it can cause underestimated or overestimated association between independent and dependent variables.

For the future and more detailed studies, we recommend to use Development and validation of a smartphone addiction questionnaire (SPAQ). [20] It explores the smartphone usage, the level of addiction to smartphones, different activities and applications, and the level of smartphones addiction symptoms appearance. Moreover, the Epworth Sleepiness Scale can also be used. [21] [23] This tool measures how likely are the sample to fall asleep in some certain situations, in comparison to only feeling tired. This will be more resemblance to the usual way of life in recent times. If the sample did not experience it recently, they will need to think about how they have affected them in the past, thus increases the reliability. Furthermore, Verbal Rating Scale [22] can be used in replace to PSQI to measure pain intensity of headache.

In conclusion, our study expanded the literature to include smartphone radiation and duration spend on smartphone with neurological symptoms such as tingling, vision problems, sleep disturbances, headache and stress level. Ultimately there is a positive association seen between the independent and dependent variables.

5. Conclusion

In conclusion, our study expanded the literature to include smartphone radiation and duration spend on smartphone has association with neurological symptoms such as tingling, vision problems, sleep disturbances, headache and stress level among the university students. Although the effect of usage of smartphone on our lives are rising, little research has been carried out on this issue. Ultimately high frequency of smartphone use and the radiation that is emitted from smartphones has risk factor for reporting of neurological problems. Thus, our study provides an important contribution as there is a positive association seen between the independent and dependent variables. Finally, the students must set their limit to reduce the usage of smartphone as it can bring some consequences in our lives.

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