DOES THE NOCTURNAL MOBILE PHONE USAGE AFFECT THE COGNITION AND QUALITY OF SLEEP?

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Abstract: **Background & Objectives:** The direct exposure to blue light that has been emitted from personal electronic devices can cause damage to the retina thus causing impairment of cognition. It also suppresses the production of melatonin, a hormone that helps to regulate the sleep cycle. The aim of this study is to assess the effects of nocturnal mobile phone usage on cognition and quality of sleep. **Methods:** The study was carried out using 60 nocturnal mobile phone users in Venkateshwaraa Medical college Hospital and Research Centre by measuring their cognitive functions and sleep quality. Comparison of cognitive function tests and sleep scores between the groups was done using one-way ANOVA and post-hoc tests. **Results:** The cognitive function tests scores were decreased significantly in nocturnal mobile phone users and this change was more pronounced with more usage at night. The PSQI scores are significantly increased in nocturnal mobile phone users. **Interpretation & Conclusion:** From the results we can conclude that nocturnal usage of mobile phones has negative influence on cognitive functions and increased sleep disturbance in subjects with greater mobile phone usage, on comparison with the non mobile phone users at night.

Key Words: Cognitive functions, Melatonin, Mobile phones, Sleep quality index.

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Introduction:

The total users of mobile phone are estimated to be increased to about 4.77 billion in 2017. About 75% of teenagers now own mobile phones. The mobile phone and smart phone ownership among teens has grown substantially since 2011. Fully 95 % of teens are online, a percentage that has been consistent since 2006. In many ways, teens represent the leading edge of mobile connectivity and the patterns of their technology use often signal future changes in the adult population. According to vision council the smaller devices which are to be held at 8 – 12 inches from the eyes foster the conditions for digital eye strain, characterized by blurred vision, eye fatigue, head neck and back pain. The various studies indicate that there may be relationship between daytime sleepiness and nocturnal mobile phone usage. The blue light from personal electronic devices has also been linked to serious physical and mental health problems. The direct exposure to blue light can cause damage to the retina. Light Emitting Diode (LED) is the basic lighting component in screens of phones, television sets, and computers. LED decreases the cellular viability by 75%-99%, increases cellular apoptosis by 66%- 89%[1]. The American Macular Degeneration Foundation warns that retinal damage caused by blue light may lead to macular degeneration which causes the loss of central vision. Some statistical evidence shows that mobile phone usage can lead to blurring of vision, secretions from eye, inflammation and lacrimation of eyes. Also there is decreased sperm count and testicular weight in rats which was exposed to electromagnetic radiations from 3G mobile phones[2]. Various studies are going on related to the cell phone addiction. It has become an indispensible part of the human life but this has crossed the point of necessity to the point of addiction. Thus it is high time we take necessary steps to bring the harmful effects of cell phone usage to lime light. The exposure to diffuse blue light for 3-6 hrs resulted in cell apoptosis which leads to early macular degeneration in rats[3]. It also suppresses the brain's production of melatonin, a hormone that helps to regulate the sleep cycle[4]. The increase in media use is associated with multiple negative outcomes including decreased sleep time and increased tiredness[5]. The smart phones ruin sleep and the associated health consequences that range from obesity to genetic disruption and memory problems[6]. Mobile phone usage has been associated with impairment of cognitive functions[7]. Cognition is the higher brain

function enabling the individual to experience the world by a complex process of interpretation of sensory information. It includes evaluation categorization and discrimination of stimulus. As very little information is available on the effects of nocturnal mobile phone usage on cognition and sleep , this study has been chosen.

Materials and Methods:

An observational study was conducted among 60 volunteers aged between 18 and 23 years in the department of Physiology at Sri Venkateshwaraa Medical College Hospital and Research Centre in Puducherry, after obtaining Instituitional Ethical Committee (IEC) clearance before commencement of the study. After obtaining the prior consent from the subjects, they were divided into 4 groups. Group 1: Non mobile phone users at night. Group 2: Nocturnal mobile phone users (< 1 hr per day). Group 3: Nocturnal mobile phone users (1 – 2 hrs per day). Group 4: Nocturnal mobile phone users (> 2 hrs per day). The subjects were selected by convenient sampling method and the selection was based on the following criteria. The subjects with history of organic brain disease likely to reduce cognition, prolonged hospitalization likely to reduce attention span and visual abnormality were excluded. Informed written consent was obtained from all the subjects prior to the study. An ID code was assigned for the subjects to maintain confidentiality of the data obtained.

COGNITIVE FUNCTIONS:

A total of 60 subjects of age group 18-23 were recruited and after measuring their anthropometric parameters the cognitive function in all the four groups was assessed. The following tests were done to assess the cognitive functions-

Mini mental status examination (MMSE): It was done by asking a set of 11 questions under following section like orientation, registration, attention, calculation, recall and language. The questions are very basic like name of year, season, date, month etc. The total score will assess and categorize the subject under category of whether she is alert/coma/stupor/drowsy[8].

Digit symbol substitution test (DSST): The test was done to assess neuropsychological activity of brain. It consists of (eg. one digit – symbol pair, 1/-,7/^, 9/=) followed by a list of digits. Under each digit the subject should write down the corresponding symbol as fast as possible within 30 seconds. The number of correct symbols within the allowed time is measured and score awarded.

Letter Digit Substitution Test (LDST): The test was done to assess cognitive function. It consists of (eg nine letter), digit pairs eg (w/1, b/2, t/3, p/4, v/5 ……. j/9) followed by list of alphabets. Under each alphabet, the subject must be instructed to write down the corresponding digit within 60 seconds of time period. The correct digit will be considered as a score.

Wechsler memory scale- revised (WMS-R): Two different tests were done in this type of cognitive function tests.

(a) Spatial addition sub test: It assesses visuo-spatial storage and manipulation in working memory. The examinee was shown a grid with blue or red dots on it for 5 seconds. They were asked to remember the location of the blue dots and ignore red dots that appear on page. The examinee was then shown a second page with blue and red dots for 5 seconds, examinee then adds the two visual images together. The examinee must place the blue dot in the grid in location where they saw blue dots on either page and white dot in location where blue dot appeared in common.

(b) Design sub test: The examinee was shown a page with designs placed in grid. There are 4 times having 4,6,6,8 designs for examinee to remember respectively. The examinee was asked to remember the designs and the location of designs. After seeing the stimulus page for 10 seconds, the examinee was given puzzle grid and cards with designs on them. The examinee must select the cards with correct designs and place them in puzzle grid in correct position. After 20-30 min of delay, the examinee was given the cards to place in the grid. Following the delay recall task, a delayed recognition is administered scores are calculated for total immediate, immediate content, immediate spatial, total delayed, delayed content and delayed spatial. The self-reported sleep quality was quantitatively assessed using a Pittsburgh Sleep Quality Index (PSQI)[6] in all the study groups.

Statistical Analysis

Data were presented as mean ± standard deviation. One way ANOVA test was performed to find whether scores of different groups differ significantly. To test inter group significant difference, by keeping group 1 as control, multivariate ANOVA test was performed. The data were analyzed by using SPSS 17 software. Statistical probability of P<0.05 was considered to be significant.

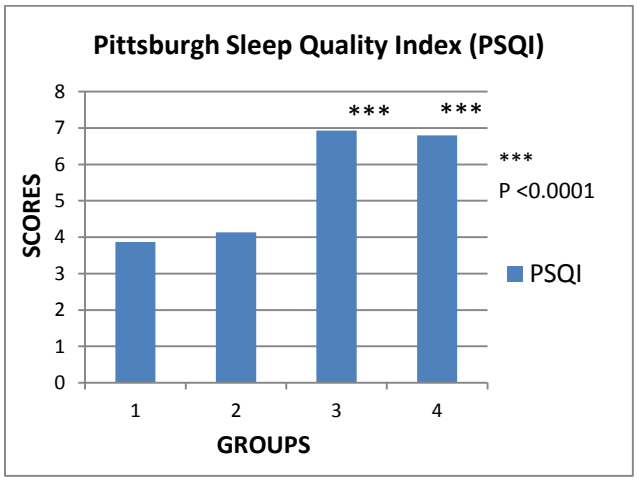
Results:

Table 1: Cognitive function tests in nocturnal mobile phone users

GROUP	MMSE	DSST	LDST	WMS1	WMS 2
1	26.93±2.86	43.33±6.63	39.93±5.45	4.2±1.01	3.87±0.91
2	26.93±2.84	38.47±5.47	43.6±3.91	3.4±1.45	4.27±0.96
3	27.00±2.07	42.00±6.60	41.27±4.78	3.8±1.14	5.00±1.13
4	26.53±2.44	42.00±5.25	40.40±5.44	3.07±1.43	3.73±0.96
F test(P value)	0.103	0.158	0.194	0.096	0.003*
Multivariate ANOVA (P value)					
1 vs 2	1.00	0.03*	0.04*	0.09	0.10
1vs 3	0.944	0.11	0.46	0.39	0.71
1vs 4	0.672	0.11	0.79	0.01*	0.003*

Table 1 shows that there was a significant decrease in DSST scores (P=0.03) and LDST scores (P=0.04) between groups 1 vs 2. The WMS 1 scores (P=0.01) and WMS 2 scores (P=0.003) were also significantly decreased between groups 1 vs 4.

Figure 1: Pittsburgh sleep quality scores in nocturnal mobile phone users



The PSQI scale scores were significantly increased (P < 0.0001) between groups 1 vs 3 and 1 vs 4.

Discussion:

In our study, the scores of cognitive function tests decreased significantly in nocturnal mobile phone users and this change was more pronounced with more usage at night. In a study reported by Abramson et al[7], the overall mobile phone use was associated with faster and less accurate responding to higher level cognitive tasks. On the contrary, Vecchio et al[9] reported that the exposure to electromagnetic fields of Global System for Mobile Communications, phone for 45 min in adults enhanced human cortical neural efficiency and simple cognitive- motor processes. In a study reported by Mamta Mohan et al[10], there was no significant differences in N100, P200, N200 and P300 latencies of event – related potentials and the chronic exposure to mobile phones did not significantly impair cognition. In a prospective cohort study conducted by Redmayne et al[11], in Australian primary school children, the use of mobile and cordless phones had an impact on cognitive functions.

The PSQI scale scores are significantly increased in groups 3 and 4 indicating a strong negative correlation between sleep quality and duration of mobile phone use at night. The blue light from personal electronic devices has also been linked to serious physical and mental health problems. The night time exposure to blue light emitted by smart phones, tablets, laptops and other LED screens may be damaging our vision. It also suppresses the production of hormone melatonin, a hormone that helps to regulate the sleep cycle. Bruch et al[5] have reported that the prolonged use of cellular telephones may lead to reduced melatonin metabolite excretion, thus disrupting the sleep cycle. In a study done by Smolensky et al[12], the routine

exposure to artificial light at night leads to frequent nocturnal melatonin synthesis suppression and sleep wake cycle disruption with sleep deprivation. In a study by Thomee et al[13], high mobile phone use was associated with sleep disturbances and symptoms of depression for both men and women. Our finding was also supported by Loughran et al[14], where mobile phone like emissions affect the EEG during non-REM sleep.

On the contrary, a study reported by Ahlers et al[15], showed that radio frequency electromagnetic fields exposure at three mobile phone frequencies (GSM – 900, GSM-1800, Universal mobile Tele communication system) has no acute efforts on mouse retinal ganglion cell responses under constant temperature condition. The contrary finding was also reported by by Demirel et al[16] on effects of third generation mobile phone – emitted electromagnetic radiation on oxidative stress parameters in eye tissue and blood of rats, 3G mobile phone radiation does not lead to harmful effects on eye tissue and blood in rats. The recently developed figures of merit for circadian luminous efficacy of radiation (CER) and circadian illuminance (CIL) related to human health and circadian rhythm were measured to compare 3 kinds of smartphone displays. The CIL values for social network service messenger screens from all 3 displays were higher than 41.3 biolux in a dark room at night. The highest CIL values (50.9 biolux) correspond to melatonin suppression values[17].

Conclusion:

Thus we conclude from this study that nocturnal usage of mobile phones have negative influence on cognitive functions thus increasing eye strain due to nocturnal usage of mobile phones. There was increased sleep disturbance in subjects with greater nocturnal mobile phone usage, on comparison with the non mobile phone users at night (subjects belonging to group 4 is found to have higher sleep disturbance when compared with control group). Thus the study has thrown light on deleterious effects of nocturnal mobile phone usage which was not given much importance previously. The student community needs to be aware of harmful effects of nocturnal mobile usage, as this has been found to be one of the major factors to increase eye strain which in future may emerge as a risk factor for reduction in cognitive function, blindness and also several related carcinomas.

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