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Smartphone Usage and its Relation to Visual Reaction Time, Physical Activity and Inattention among Medical Students: A Cross-sectional Study

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ABSTRACT

Smartphones have many useful features other than their use for communication. Overuse of smartphones can cause physical and mental health problems. The aftermath of the pandemic has worsened the situation due to increased online activities leading to alterations in the cognitive functions of the brain. To study the effect of increased usage of mobile phones on lack of attention and visual reaction time among young adults and also to find the association between physical activity and lack of attention among medical students. This cross-sectional study was done among 501 students in the age group of 18-24 years. The information about mobile phone usage and the data about the severity of inattention was collected by using questionnaires. Visual Reaction Time (VRT) was calculated by conducting the Ruler-Drop experiment. Data were statistically analyzed using the Chi square test. It was observed that 30% participants who were using mobile phone for 6-8 hrs experienced significant inattention related symptoms. It was also observed that as the duration of physical activity increased, the inattention symptoms decreased. The mean duration of mobile phone usage in a day was 3.87 hrs. The mean VRT was 0.20 sec. However, there was a negative correlation between Mobile phone usage and VRT. This study concludes that people who spent 3-4 hrs on mobile phone per day, had significant inattention-related symptoms and increased physical activity decreased these symptoms. However, the VRT decreased with the increased usage of mobile phones.

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Key Words
Internet browsing, behavioural problems, sedentary lifestyle, obesity

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INTRODUCTION

The usage of mobile phones has become ubiquitous during the current age. This is due to multiple factors such as cheaper prices of internet, ease of usage and the number of endless utilities available in it. The aftermath of the pandemic has worsened the situation even more due to the conduction of many offline activities via the online mode such as online classes, meetings and researching study material online. Consequently, such close interaction of humans with mobile phones has led to alterations in the cognitive functions of the brain[1].

A previous study has shown that increasing mobile usage has led to a slower brain processing time as seen by the increase in the visual reaction time (VRT)[2]. Reaction time tells about the brain's central information processing speed and peripheral response time. Slower reaction time can prove very fatal when it comes to reacting immediately in life-threatening conditions such as accidents. Conclusive data obtained from this study can encourage people to monitor their mobile phone usage[2]. It is worth noting that India is currently the world's second-largest mobile phone user, with young adults between the ages of 18 and 24, having the highest consumption rates[3,4].

Inattention and Attention Deficit Hyperactivity Disorder (ADHD) -like disorders are rising amongst young adults as their brains are more prone to absorb the radio frequency electromagnetic fields from mobile phones[5,6]. By evaluating visual reaction time and attention span in young adults, the shift in cognitive functioning can be determined. Inattention and a deviation of reaction time from normal are important parameters related to increased mobile phone usage. In one study conducted by Feizhou Zheng *et al*.[7], it was seen that that the prevalence of inattention was significantly higher in students owning mobile phone compared to other students. Similarly, in another study done by Jage *et al*. that was done to look for changes in reaction time using methods such as the Ruler-Drop method it was found that there was a significant negative correlation between visual reaction time and mobile phone usage[8].

The study was done in a medical college on young adults from the age group 18-24 years from various health science courses. As many of these students have to use their phones for longer times for education purposes, the data collected from the questionnaire and experiment conducted on them would be conclusive. The hypothesis of this study is that increased mobile phone usage does indeed affect the cognitive functions of the brain which leads to increased visual reaction time and inattention. The main objectives of this study were to study the effect of increased usage of mobile phones on lack of attention among young adults and to find the relationship between usage of mobile phones with Visual Reaction time and physical activity in young adults.

MATERIALS AND METHODS

This cross-sectional study was done over a period of 2 months from 1st september 2022 to 31st october 2022, at PESIMSR, Kuppam, Andhra Pradesh The institutional ethics committee approved the study [PESIMSR/IHEC/51-22]. The subjects were briefly explained about the study and an informed consent was obtained from them before conducting the survey and experiment.

Inclusion criteria: A total of 501 college students of MBBS and Allied Health Sciences, aged between 18-24 years, who volunteered to particilpate, were included in the study.

Exclusion criteria: Students who were not interested and students below the age of 18 years and above 24 years were excluded from the study.

Sample size: Sample size was calculated using the equation:

$$n = \frac{Z^2_{1\text{-}a/2} \times s^2}{d_2}$$

Where:

n	=	Sample size
$Z^2_{1\text{-}a/2}$	=	Confidence interval
s	=	Estimated standard deviation
d	=	Desired precision[9]

Data collection: The demographic details of the subjects like Age, Sex, Course, Year of study and residence were obtained. Anthropometric measurements like height, weight, BMI (Body Mass Index), WHR (Waist Hip Ratio) and WC (Waist Circumference) were taken. Body weight was measured in kg by a mechanical scale to the nearest kg. Height was measured to the nearest 1 cm using non-stretchable measuring tape. BMI was calculated using Quetelet's index-BMI = weight in kg height^{-1} (m^2). Obesity was subdivided into the following categories:

- Class 1: BMI of 30 to <35
- Class 2: BMI of 35 to <40
- Class 3: BMI of 40 or higher
- Class 3: Obesity is sometimes categorized as "severe" obesity

Table 1: Demographic characteristics of the subjects

Demographic characteristics	Parameters	No. of subjects
Gender	Male	181 (36.1%)
	Female	320 (63.9%)
Age	<20 years	398 (79.4%)
	>20 years	103 (20.5%)
Residence	Urban	311 (62%)
	Rural	190 (38%)
Number of Inattention-related symptoms experienced by the participants	1 symptom	50 (9.98%)
	2-4 symptoms	346 (69.06%)
	5-9 symptoms	105 (20.96%)

WC was measured midway between the lowest rib and the iliac crest and hip circumference at the level of the greater trochanters with legs close together, using a non-stretchable measuring tape by an average of three measurements nearest to 0.5 cm. The WHR was calculated as WC divided by hip circumference[10]. Abdominal obesity was defined by WC>88 cm and WHR >0.8 cm. WHR was classified as follows: Normal = <0.4, overweight= 0.4-0.5, obese= 0.5-0.6 and morbidly obese = >0.6[11].

The information about daily mobile phone usage was collected by a series of questions from the offline questionnaire[7] (Table 1). The data about the Visual Reaction Time (VRT) was collected by conducting the Ruler-Drop experiment[8]. Ruler-Drop Experiment: The subject was asked to sit with their dominant elbow flexed at 90 degrees with a mid-pronated forearm and hand held out with a gap between their thumb and first finger. The investigator held the ruler vertically in between this gap with the zero coinciding with the subject's thumb. The investigator then drops the ruler without informing the subject and the subject must catch it as soon as they can. The distance traveled by the ruler is recorded by measuring the new number level that is coinciding with the thumb. Then the distance is converted into reaction time using the equation:

$$t = \sqrt{(2s/g)}$$

Where, t is reaction time, s is distance traveled by the ruler, g is acceleration due to gravity = 9.8 min sec^{-2}

This process was repeated 3 times and the mean of the 3 readings was used.

The level of Physical activity was assessed using a physical activity questionnaire. The number of hours spent in doing physical activity was recorded. The physical activity was calculated as METS (metabolic equivalents)[12]. The data about the severity of inattention was assessed according to DSM-IV-TR criteria. DSM-IV Criteria for inattentiveness is as follows: Whether the person is forgetful in daily activities, Has difficulty sustaining attention, Has difficulty organizing tasks, Often loses items necessary for completing a task, Fails to give attention to detail, makes careless mistakes, Avoids tasks requiring mental effort, Easily distracted by extraneous tasks, Doesn't follow through/fails to finish projects, Doesn't seem to listen when spoken directly. The hyperactive symptoms are as follows: Whether the person Talks excessively, Fidgets or squirms excessively, Leaves seat when inappropriate, Runs about/climbs extensively when inappropriate, Has difficulty playing quietly, Often "on the go" or "driven by a motor".

Statistical analysis: The data was entered into MS Excel and was further analyzed using SPSS version 20.0. For descriptive analysis, the categorical variables were analyzed using percentages and the continuous variables were analyzed by calculating the mean ± Standard Deviation. Categorical data were analyzed using the Chi square test. $p<0.05$ was considered statistically significant.

RESULTS

A total of 501 members participated in the study out of which 181 were male and 320 were female subjects. It was observed that 24 (30%) participants who were using mobile phone for 6-8 hrs experienced 5-9 inattention related symptoms and out of 238 subjects, majority 159 (66.81%) who used mobile phone 3-5 hrs, experienced 2-4 symptoms of inattention and the results were statistically significant (Table 2).

It was also observed that as the duration of physical activity increased, the percentage of participants having inattention symptoms decreased and the result was statistically significant (Table 3).

The mean duration of mobile phone usage in a day was 3.87 hrs. The mean Visual reaction time was 0.20 sec. It was observed that there was a negative correlation between Mobile phone usage and Visual Reaction Time (Table 4).

DISCUSSIONS

Smartphone and internet browsing has given rise to increased mental distress among youth. This can be attributed to many reasons such as decreased productivity, improper sleep cycle, inattention, hyperactivity of the brain and so on[1-4]. The use of smart phones and other gadgets has grown rapidly during last couple of decades. The menace of misuse of cell phones is growing at an alarming rate. Australia has been a world leader in this technology. Up to 94% of its population now using a mobile phone. There is increasing use by children and young adults with 23% of those between the ages of 6 and 13 owning a mobile phone[13].

There is now sufficient experimental evidence that mobile phone exposure alters brain activity in young adults[14]. Greater mobile phone use was related to lesser accuracy on working memory and associative learning tasks and greater auditory and visual reaction

Table 2: Association of duration of mobile phone usage with the number of inattention-related symptoms

How much time do you spend on your mobile phone per day?	No. of Inattention-related symptoms					
experienced by the participants	1 symptom	2-4 symptoms	5-9 symptoms	Total	χ^2 value	p-value
1-2 hrs	14 (8.19%)	136 (79.53%)	21 (12.28%)	171	19.8536	0.003*
3-5 hrs	22 (9.24%)	159 (66.81%)	57 (23.95%)	238		
6-8 hrs	13 (16.25%)	43 (53.75%)	24 (30.00%)	80		
More than 10 hrs	1 (8.33%)	8 (66.67%)	3 (25.00%)	12		
Total	50 (9.98%)	346 (69.06%)	105 (20.96%)	501		

*P<0.05 Statisticaly Significant

Table 3: Association of number of hours spent in doing any physical activity with the number of inattention-related symptoms experienced by the participants

What is the amount of time spent	Number of Inattention-related symptoms experienced by the participants					
on any physical activity per day?	1 symptom	2-4 symptoms	5-9 symptoms	Total	χ^2 value	p-value
10-20 minutes	21 (7.95%)	189 (71.59%)	54 (20.45%)	264	13.6009	0.034*
30-40 minutes	18 (10.65%)	106 (62.72%)	45 (26.63%)	169		
60-70 minutes	8 (18.60%)	31 (72.09%)	4 (9.30%)	43		
More than 2 hrs	3 (12.00%)	20 (80.00%)	2 (8.00%)	25		
Total	50 (9.98%)	346 (69.06%)	105 (20.96%)	501		

*p<0.05 statisticaly significant

Table 4: Pearson's Correlation between Mobile Phone Usage and Visual Reaction Time

Parameters	Mean value±std dev	Minimum	Maximum	r-value	p-value
mobile phone usage (hrs)	3.87+/-1.37	1 hr	8 hr	-0.050	1.00
Visual reaction time (sec)	0.20+/-0.01	0.15 sec	0.24 sec		

time. Individuals who used mobile phones perform quicker but are less accurate on a number of tasks, suggesting that they are more impulsive than others, resulting in a quick, but less accurate, solution[13]. In our study, the parameters considered were symptoms of inattention, Visual reaction time and their relationship with mobile phone usage. The level of physical activity and its relation to inattention was also analyzed. In our study, it was seen that overall increased mobile phone usage, including making calls and browsing the internet causes increased symptoms of inattention. In a study done by Feizhou *et al*.[7], a similar finding was reported and it was concluded that decreasing mobile phone usage to less than 60 min per day decreased the symptoms of inattention among adolescents. A similar finding was observed in a study done by Konok *et al*.[15] It was also observed in our study that the symptoms of inattention decreased with increased physical activity. The finding of our study was similar to that of a study done by Andreas W. A, van Egmond-Fröhlich *et al*., in which the symptoms of inattention decreased with increased physical activity[5]. In another study done by Selinus *et al*.[16], it was concluded that decreased physical activity lead to inattention.

In our study 249 out of 501 participants volunteered for the Ruler- Drop experiment. The results showed that there was a negative correlation between the visual reaction time and the number of hours of mobile phone usage. Our findings were similar to the findings of a study done by Gada, Dhasal, in which there was no correlation between mobile phone use and Visual reactioon time[17]. In another study done by Sini and Kusumadevi[18], it was concluded that increased screen time decreased the visual reaction time[19]. However, in a study done by Shah *et al*.[19], it was seen that Visual reaction time increased with increased mobile phone usage. Based on the findings of our study, it appears that mobile phones help make the somatosensory cortex of the brain stronger due to the fast activities like scrolling, swiping or playing games that one has to do while using mobile phone[20]. Individuals who spend majority of their mobile usage time playing games that require immediate reaction, will have faster reaction time than others. Hence, it can be concluded that instead of the reaction time getting longer, it is getting shorter due to sharper responses and hyperactivity of the brains of those who use mobile phones more often[16]. In another study done by Jage et al, it was seen that visual reaction time increased with increased mobile phone usage. In our study, 98% of the participants were using their mobile phones for 4-6 hours. Similar findings were observed in a study done by Körmendi[4], in which 97% of youth were using mobile phones for 4-6 hrs per day.

Limitations: Firstly, the study can be done on a larger sample size. The Ruler drop experiment can be done on both the dominant and non-dominant hand. Higher duration of mobile phone usage (8-10 hrs) and its effect on reaction time and other variables can be studied in future.

CONCLUSION

The findings obtained from the present study suggest that there was significant correlation between mobile phone usage and inattention. This study also concludes that there was a significant correlation between physical activity and inattention. It was also concluded from the study that there was no significant correlation between mobile phone usage and reaction time. Instead, there was a weak negative correlation suggesting that reaction time is decreasing in people with increased mobile phone usage. The overall

findings of the results of this study indicate that increased mobile phone usage can lead to decreased physical activity and increased inattention. But, when it comes to reaction time, increased mobile phone usage shows faster reaction time in participants.

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