

## Original Research Article

# USE OF SMARTPHONE AND COGNITIVE FUNCTION DISTORTION IN INDIAN ADULT POPULATION: A CORRELATIONAL STUDY

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Received : 10/10/2025  
Received in revised form : 04/12/2025  
Accepted : 22/12/2025

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DOI: 10.70034/ijmedph.2026.1.521

Source of Support: Nil,  
Conflict of Interest: None declared

Int J Med Pub Health  
2026; 16 (1); 3029-3035

### ABSTRACT

The recent development of the multifunctional smartphone and its subsequent global popularity has changed the communication and information landscape; remolded the interests, values, and desires of many users; and triggered concerns around the world about overuse and addiction. The present study's aim was to investigate the correlation of the usage of smartphones with cognitive function impairment in the Indian adult population. The present cross-sectional study was conducted on 251 Indian adults who were using smart mobile phones. This study was conducted in the Department of Physiology, Pravara Institute of Medical Sciences Loni Ahliya Nager India. Knowledge, attitude and practices were assessed by interview using a predesigned proforma. The Montreal Cognitive Assessment (MOCA) tool was employed to assess the cognitive functions, comparison was made between daily mobile phone usage group and their correlated Montreal Cognitive Score (MOCA). Written informed consent was taken from all participants. The mean age for 251 Indian adult participants was 31.23±12.76 years. More than 80% of the participants used their mobile phone for more than two hours daily. About 60% of the participants were not aware of the side effect of the radiation generated from mobile phone. The participants showed a decrease in MOCA score with increased daily mobile phone usage (MOCA=26.8 for <1 hour daily usage, 26.3 for 1-2 hours, and 24.6 for >2 hours with P< 0.05). In addition, participants showed decreased MOCA score by keeping their mobile phone near their pillow while sleeping; MOCA=23.99 for near pillow groups and >25.5 for the groups that placed their mobile phone away from the pillow. This study concludes excessive use of mobile phones can cause cognitive function impairment. Strict policies must be implemented to control the use of smartphones in order to minimize the effects on mobile phone radiation on cognition. The media has to be on the forefront in educating the public about the proper usage of mobile phones.

**Keywords:** Smartphone use severity, cognitive domains, Hazards, Radiations, MOCA, and learning.

## INTRODUCTION

The use of smartphones has become pervasive in contemporary life, and they have evolved into a vital instrument for communication, access to information, and entertainment. On the other hand, this pervasiveness raises worries about the possibility of addiction and excessive use.<sup>[1]</sup>

The idea of smartphone addiction, which is characterized by excessive and problematic use, has arisen as an important topic of inquiry, particularly with regard to the influence that it has on cognitive and mental health. There is evidence from recent research that suggests that addiction to smartphones may have an effect on a variety of facets of human cognition and mental well-being. The range of these impacts includes alterations in attention, memory,

and stress levels, as well as disruptions in sleep patterns.<sup>[2]</sup> Based on studies of Griffiths and colleagues,<sup>[3]</sup> it was found that earlier, the use of mobile phones was for communication and the risk of problematic use was minimal. However, now the risk of addiction is potentially higher for mobile phones as they include applications that facilitates in the alteration of user identity (e.g., gaming, social networking, etc.).

On the basis of a meta-analysis conducted on 6 Indian studies which enrolled 1304 participants, it was found that the smartphone addiction magnitude ranged from 39% to 44%. As reported most families do not use landlines, considering that both the parents have smartphone, the young population get ready access to it.<sup>[4]</sup>

The smartphone is a medium that might interfere with sleep, and its usage can often turn into behavioural addiction. Smartphone addiction is characterized by compulsive behavioural patterns, functional impairments, withdrawal symptoms when smartphone use is suspended, and tolerance manifesting in excessive use.<sup>[5]</sup> Excessive smartphone use is positively correlated with impulsivity,<sup>[6]</sup> poor sleep quality,<sup>[7]</sup> and bedtime procrastination.<sup>[8-11]</sup>

There has been evidence that media-multitasking has significant impact on working memory, increase in impulsivity, changes in neural structures and negative impact on academic outcomes during learning.<sup>[12]</sup> Mobile phones that generate notifications, auditory and tactile in order to alert for incoming messages also has a negative impact on attention. Even though these notifications are short in duration they can lead the individual to engage in task irrelevant thoughts or lead to wandering of mind thus causing damage to task performance.<sup>[13]</sup> For all the media attention that this subject garners, the supporting scientific literature is still in its nascent stages. The present paper aims to consolidate and integrate some of the key empirical evidence that has emerged regarding the association between smartphone technology and cognitive and affective functioning. According to the literature, mobile phones can have a harmful impact on human health. According to the World Health Organization (WHO), exposure to Radiofrequency Electromagnetic Field Radiation (RF-EMFR) created by mobile phones raises body core temperature and can impair cognition processes. Children exposed to RF-EMF radiation had impaired motor abilities, as well as attention span and working memory, as well as poor attention and focus. Furthermore, the literature acknowledges the negative consequences of smartphones.<sup>[14]</sup>

The widespread use of mobile phones has raised concerns about radiofrequency waves they emit. Radiofrequency signals from cell phones can cause bodily tissues to heat up. In a study, after a 30 min confrontation of a cell phone with brain tissue, the brain temperature increased by 4.5°C.<sup>[15]</sup> Cell phone use near the head has raised concerns about potential harm to the central nervous system, both in children

and adults.<sup>[16]</sup> The brain is exposed to radiofrequency radiation during phone conversations.<sup>[17]</sup>

## MATERIALS AND METHODS

The present cross-sectional study was conducted in the Department of Physiology, MGM Medical College, Sambhaji Nager, Maharashtra, India during April 2025 to October 2025. A total of 251 Indian adult volunteers aged from 14-64 years using mobile phones were invited to participate in this study. Knowledge, attitude and practices were assessed by interview using a specially designed questionnaire. Three questions were designed to determine the awareness of participants about mobile phone hazards. The Montreal Cognitive Assessment (MOCA) was used to assess cognition.

From all the participants, a written consent was obtained who voluntarily agreed to join the research project, where they have the opportunity to read the research objectives and join or withdraw from the research at any time, without any profits or penalties. Subjects were recruited through convenience sampling technique. MOCA scores range between 0 and 30, score of 26 or over was considered normal, lower scores <26 indicate mild cognitive impairment (MCI).<sup>[18]</sup>

Smart phone users of age group 14-64 years of both male and female gender having educational qualification of minimum SSC pass were included in the study. Those who were diagnosed cases of neurological or psychiatric disorders, patients taking medications which are known to affect cognition, subjects with history of severe head injury, subjects living near high voltage electricity towers, subjects with chronic debilitating disorders such as diabetes mellitus, cardiac failure, and malignancy were excluded from this study.

Statistical Analysis was done by entering the data into the computer, SPSS V. 22 and Microsoft Windows was used. Continuous variables were expressed as the mean  $\pm$  standard deviation and descriptive data were expressed as percentages (%). Variables were compared between different groups by oneway ANOVA regarding all variables of knowledge, attitude and different practices of smart mobile phone users. Proportions were compared between different groups using Chi-square test. A p value <0.05 was considered significant.

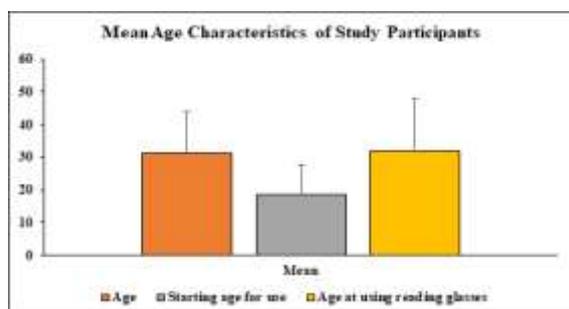
## RESULTS

A total of 251 participants aged 14-64 years were included in the study. The mean age of the participants was  $31.23 \pm 12.76$  years. The mean age at initiation of mobile phone use was  $18.69 \pm 9.15$  years, while the mean age at which participants began using reading glasses was  $31.89 \pm 15.97$  years. [Figure 1] The overall mean Montreal Cognitive Assessment (MOCA) score among the study

participants was  $24.08 \pm 2.36$ , with scores ranging from 16 to 30 [Table 1].

**Table 1: Demographic characteristics of all participants and MOCA Scores (n=251)**

Characteristics of participants	Mean	SD	Minimum	Maximum
Age	31.23	12.76	14	64
Starting age for use	18.69	9.15	7	52
Age at using reading glasses	31.89	15.97		
Educational Level: n (%)				
Secondary	96 (38.2)			
Bachelor	120 (47.8)			
Higher	35 (13.9)			
Years of usage: n (%)				
1 to 5 years	38 (15.1)			
6 to 10 years	59 (23.5)			
>10 years	154 (61.4)			
MOCA	24.08	2.36	16	30
MOCA: Montreal cognition assessment.				
Values are expressed in mean and standard deviation.				



**Figure 1: Age Profile of Study Participants and Age at Initiation of Smartphone Use**

With respect to educational status, 47.8% of the participants had completed a bachelor's degree, 38.2% had completed secondary education, and 13.9% had higher education. Regarding the duration of mobile phone use, the majority of participants (61.4%) had been using mobile phones for more than 10 years, while 23.5% reported usage for 6–10 years, and 15.1% for 1–5 years [Table 1].

The attitudes and practices related to smartphone usage are summarized in [Table 2].

**Table 2: Attitude and practices of mobile phone users**

Attitude of mobile phone users	Categories	Number (%)
Daily usage	<1 hour	12(4.8)*
	1-2 hour	35(13.9)
	>2hours	204(81.2)
How do you use your mobile?	Handheld	155(61.8)*
	Earphone	45(17.9)
	Speaker	39(15.5)
	Bluetooth	12(4.0)
Do you live near mobile tower	Yes	46(18.3)*
	No	205(81.7)
Do you use reading glasses?	Yes	62(24.7)*
	No	189(75.3)
Where do you put your mobile while sleeping?	Near pillow	136(54.2)*
	Inside bedroom	99(39.4)
What is your dominant hand?	Right	228(90.8)*
	Left	23(9.2)
Where do you put the mobile while calling?	Right ear	178(70.9)*
	Left ear	40(15.9)
	Variable	33(13.1)
Where do you put the mobile when not used?	Upper pocket	8(3.2)*
	Lower pocket	129(51.3)
	Variable	49(19.5)
Do you think you are dependent on mobile?	Yes	140(55.7)*
	To some extent	82(32.6)
	No	29(11.6)
Do you want to quit using mobile?	Yes	31(12.3)*
	To some extent	61(24.3)
	No	159(63.3)
ANOVA comparison *p <0.001		

A large proportion of participants (81.2%) reported using their mobile phones for more than two hours daily, whereas 13.9% used them for 1–2 hours, and only 4.8% used them for less than one hour per day.

In terms of mode of mobile phone use during calls, 61.8% of participants used the handheld mode, while 17.9% used earphones, 15.5% used speaker mode, and 4.0% used Bluetooth devices. Only 18.3% of

participants reported living near a mobile tower, whereas the majority (81.7%) did not. Additionally, 24.7% of participants reported using reading glasses. Regarding sleep-related practices, 54.2% of participants reported placing their mobile phones near their pillow while sleeping, whereas 39.4% kept their phones inside the bedroom but away from the pillow. The majority of participants (90.8%) were right-hand dominant.

When asked about the ear used during phone calls, 70.9% reported predominantly using the right ear, 15.9% used the left ear, and 13.1% reported variable use. With respect to the placement of mobile phones when not in use, 51.3% of participants kept the phone

in the lower pocket, 19.5% reported variable placement, and 3.2% kept it in the upper pocket.

Perceived mobile phone dependence was reported by 55.7% of participants, while 32.6% reported dependence to some extent, and 11.6% denied any dependence. When asked about willingness to discontinue mobile phone use, 63.3% reported no intention to quit, 24.3% indicated willingness to some extent, and 12.3% expressed willingness to quit completely. Statistical comparison using ANOVA demonstrated significant differences among variables ( $p < 0.001$ ) [Table 2].

The awareness of potential adverse effects of mobile phone radiation among participants is presented in [Table 3].

**Table 3: Awareness of mobile phone side effects in all participants**

Awareness of the side effect of mobile	Categories	Number (%)
Aware of putting mobile 5 cm away from your body reduces radiation effect 4 times	Do not know	170 (67.7)
	To some extent know	31 (12.3)
	Know	50 (19.9)
WHO Announcement (mobile phone is a possible cause of cancer)	Do not know	157 (62.5)
	To some extent know	62 (24.7)
	Know	32 (12.7)
ACS Announcement (mobile phone is a possible cause of Brain cancer)	Do not know	174 (69.3)
	To some extent know	51 (20.3)
	Know	26 (10.3)

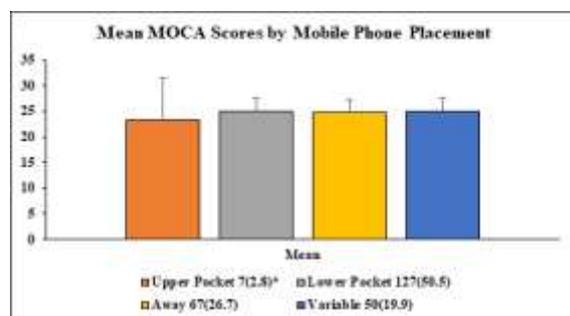
Approximately 67.7% of participants were unaware that maintaining a distance of at least 5 cm from the body can significantly reduce radiation exposure, whereas 12.3% had partial awareness and 19.9% were aware of this information. Regarding the World Health Organization (WHO) statement suggesting that mobile phone radiation may be a possible cause of cancer, 62.5% of participants were unaware of this information, while 24.7% had partial knowledge and

12.7% were aware of it. Similarly, 69.3% of participants were unaware of the American Cancer Society (ACS) announcement indicating a possible association between mobile phone radiation and brain cancer.

The association between MOCA scores and the placement of mobile phones when not in use is shown in [Table 4 & Figure 2].

**Table 4: MOCA scores and the placement of mobile while not calling**

Placements	MOCA	Mean	Standard Deviation
Upper Pocket	7(2.8)*	23.28	8.286
Lower Pocket	127(50.5)	25.02	2.57
Away	67(26.7)	24.79	2.516
Variable	50(19.9)	25.07	2.43
Total		24.91	2.852



**Figure 2: Association Between Mobile Phone Placement and Montreal Cognitive Assessment (MOCA) Scores.**

Participants who kept their phones in the upper pocket demonstrated a mean MOCA score of  $23.28 \pm 8.286$ , whereas those keeping the phone in the lower pocket had a mean score of  $25.02 \pm 2.57$ . Participants who kept their phones away from the body had a

mean MOCA score of  $24.79 \pm 2.516$ , while those reporting variable placement showed a mean score of  $25.07 \pm 2.43$ . The overall mean MOCA score for the study population was  $24.91 \pm 2.852$ .

These findings suggest variations in cognitive performance across different patterns of smartphone use and placement, as reflected by differences in MOCA scores among the groups.

## DISCUSSION

The present study explored the relationship between smartphone usage patterns and cognitive performance among Indian adults using the Montreal Cognitive Assessment (MOCA). The findings demonstrate that prolonged smartphone usage, specific behavioral practices related to smartphone handling, and limited awareness of potential health

hazards associated with mobile phone radiation may be associated with variations in cognitive performance.

The demographic profile of the study population revealed a relatively young cohort, with a mean age of  $31.23 \pm 12.76$  years, reflecting a population with substantial exposure to modern digital technologies. The mean age at initiation of smartphone use was  $18.69 \pm 9.15$  years, indicating early adoption of mobile technology among participants. Similar trends have been reported globally, where the increasing accessibility of smartphones has led to widespread use among adolescents and young adults. The early exposure to smartphones may influence behavioral habits and cognitive engagement with digital devices over time.<sup>[19]</sup>

In the present study, the majority of participants (61.4%) reported using smartphones for more than 10 years, suggesting long-term exposure to mobile technology. Long-term engagement with digital devices has been associated with increased reliance on electronic communication, multitasking behavior, and continuous information processing. Previous research has suggested that prolonged interaction with digital media may influence cognitive processes such as attention regulation, working memory capacity, and information filtering.<sup>[20]</sup>

One of the most notable observations in the current study was that more than 80% of participants reported using smartphones for more than two hours daily. The increasing duration of smartphone usage has raised concerns regarding its potential impact on cognitive functioning. Digital multitasking and frequent switching between applications may increase cognitive load and reduce the ability to sustain attention on a single task. Several studies have demonstrated that excessive smartphone use is associated with decreased attentional control and impaired working memory performance.<sup>[21]</sup>

The behavioral practices related to smartphone usage observed in this study also provide important insights into potential exposure patterns. A significant proportion of participants (61.8%) reported using handheld mode during calls rather than earphones or speaker mode. Direct placement of smartphones near the head increases exposure to radiofrequency electromagnetic fields (RF-EMF). Although the biological consequences of RF-EMF exposure remain a subject of ongoing investigation, some studies have explored potential associations between radiofrequency exposure and alterations in neural activity and cognitive performance.<sup>[22]</sup>

Concerns regarding radiofrequency radiation emitted by mobile devices have been evaluated by several international health agencies. The International Agency for Research on Cancer (IARC) classified radiofrequency electromagnetic fields as possibly carcinogenic to humans (Group 2B) based on limited evidence linking exposure to certain types of brain tumors.<sup>[23]</sup> While definitive causal relationships remain unestablished, the increasing global prevalence of smartphone usage highlights the need

for continued research into the long-term health implications of RF-EMF exposure.

Another important behavioral finding in the present study was the practice of keeping smartphones near the pillow during sleep, reported by 54.2% of participants. Nighttime smartphone use has been associated with sleep disturbances due to blue-light emission from screens, psychological stimulation from digital interactions, and disruptions caused by notifications. Sleep deprivation and poor sleep quality are known to adversely affect cognitive processes including attention, executive functioning, and memory consolidation.<sup>[24]</sup> Consequently, excessive smartphone usage before bedtime may indirectly contribute to cognitive decline through sleep-related mechanisms.

The results of the present study also revealed low levels of awareness regarding the potential health risks associated with mobile phone radiation. A majority of participants were unaware that maintaining a minimum distance between the device and the body may reduce radiation exposure. Similarly, awareness regarding international health advisories on mobile phone radiation was limited. These findings highlight the need for greater public health education regarding safe smartphone usage practices, particularly in developing countries where smartphone adoption is rapidly increasing.

The relationship between smartphone placement habits and cognitive performance was further explored using MOCA scores. Participants who kept their mobile phones closer to the upper body demonstrated comparatively lower mean MOCA scores than those who kept their phones farther away from the body. Although the cross-sectional design of this study does not allow causal inference, these findings suggest that smartphone usage behaviors may be associated with differences in cognitive performance.

Several mechanisms may explain the observed relationship between excessive smartphone use and cognitive impairment. Continuous exposure to digital stimuli may promote cognitive fragmentation through frequent interruptions and multitasking. Research has shown that heavy media multitaskers tend to exhibit poorer cognitive control and increased susceptibility to distraction.<sup>[25]</sup> Additionally, the constant availability of smartphones may reduce deep cognitive engagement by encouraging reliance on external digital information sources rather than internal memory processes.<sup>[26]</sup>

Experimental studies have also demonstrated that the mere presence of a smartphone may reduce cognitive capacity by diverting attentional resources. Ward and colleagues reported that individuals performed worse on cognitive tasks when their smartphone was present in the environment, even when the device was not actively used.<sup>[27]</sup> These findings suggest that smartphones may impose a cognitive burden by occupying limited attentional resources.

The present study contributes to the growing body of literature examining the potential cognitive

implications of smartphone use. The strengths of this study include a relatively large sample size, the use of a standardized cognitive screening tool, and the evaluation of multiple behavioral variables related to smartphone use such as duration of use, placement habits, and awareness regarding potential health risks.

However, certain limitations must be acknowledged. The cross-sectional design limits the ability to establish causal relationships between smartphone use and cognitive impairment. Additionally, smartphone usage patterns were based on self-reported data, which may introduce recall bias. Furthermore, several additional factors that may influence cognitive performance, including sleep quality, psychological stress, occupational workload, and screen exposure from other digital devices, were not extensively assessed in this study.

Future research should focus on longitudinal and experimental designs to better understand the long-term effects of smartphone exposure on cognitive functioning. Neuroimaging and electrophysiological studies may also help clarify the underlying neural mechanisms associated with prolonged smartphone use.

In conclusion, the present study suggests that excessive smartphone use and certain behavioral patterns related to smartphone handling may be associated with variations in cognitive performance among adults. As smartphones continue to become deeply integrated into daily life, promoting responsible smartphone usage and increasing public awareness regarding safe usage practices may help reduce potential cognitive and behavioral consequences associated with excessive digital device exposure.

## CONCLUSION

The present study provides important insights into the relationship between smartphone usage patterns and cognitive performance among Indian adults. The findings demonstrate that prolonged smartphone use, certain behavioral practices related to device handling, and limited awareness regarding potential health hazards associated with mobile phone radiation are common among the study population. A large proportion of participants reported extended daily smartphone use and behavioral patterns such as handheld calling and keeping the mobile phone near the pillow during sleep, which may contribute to increased exposure to radiofrequency electromagnetic fields and behavioral dependence on digital devices.

The analysis of cognitive performance using the Montreal Cognitive Assessment (MOCA) revealed variations in cognitive scores across different smartphone usage patterns and device placement habits. Participants who kept their mobile phones closer to the body demonstrated comparatively lower mean MOCA scores than those who maintained

greater distance from the device. Although the cross-sectional design of the study does not establish a causal relationship, the findings suggest a potential association between excessive smartphone exposure and variations in cognitive functioning.

The results of this study also highlight a substantial lack of awareness among participants regarding the potential health implications of mobile phone radiation and safe smartphone usage practices. Considering the rapidly increasing global dependence on smartphones, public health initiatives aimed at improving awareness and encouraging responsible smartphone usage may be beneficial in minimizing potential cognitive and behavioral effects associated with excessive mobile device exposure.

Future research should focus on longitudinal and experimental study designs to further clarify the causal relationship between smartphone use and cognitive performance. In addition, neurophysiological and neuroimaging investigations may help elucidate the underlying mechanisms through which prolonged exposure to digital technologies influences brain function and cognitive processes.

In conclusion, the present study suggests that excessive smartphone usage and certain behavioral practices associated with smartphone handling may be linked to variations in cognitive performance among adults. Promoting balanced and responsible use of smartphones, along with increasing public awareness regarding safe usage practices, may play an important role in protecting cognitive health in an increasingly technology-driven society.

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