Original Research Article

Study of brain derived neurotrophic factor and cognition in mobile addicts: an observational study

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ABSTRACT

Background: Smartphones are the most popular devices and most used devices which leads to uncontrolled use or addiction. Neuroplasticity is the ability of the central nervous system to modify its structure and functions as reaction to internal and external stimuli which can be measured by levels of brain derived neurotrophic factor (BDNF). Excessive smartphone uses results in negative impacts on cognition. Thus, this study aims to understand the process of neuroplasticity and cognition by studying the levels of serum BDNF in Mobile Addicts.
Methods: This observational study included 48 participants divided into two groups 1) mobile addicts (n=24) and 2) non-mobile addicts (n=24). We assessed levels of BDNF using blood test and Cognition by using a game-based app in each of the participants. We analyzed the results of the BDNF test and the Cognition test and compared the results between the two groups.
Results: In the conducted study, a comparison among mobile and non-mobile addicts showed no statistical significance in BDNF levels and Cognition scores with p value 0.4897 and 0.04897 respectively.
Conclusion: The study concludes that there is no difference in the process of neuroplasticity and cognition occurring in the brains of age and gender matched Mobile addicts and non-mobile addicts.

Keywords: Brain derived neurotrophic factor, BDNF, Cognition, Mobile addiction, Smartphone addiction

INTRODUCTION

Neuroplasticity is the property of the central nervous system to modify its connections, structures, and functions in response to any intrinsic and extrinsic stimuli which includes synaptogenesis, neurogenesis, and neuroprotection.[1] Measurement of BDNF is a valid and reliable method of studying Neuroplasticity.[2]

BDNF belongs to the neurotrophins family which is present widely in the central nervous system (CNS) highly concentrated in the hippocampus and cortex of the brain.[3] It helps in neuronal growth, differentiation, and repair, promoting neuroplasticity by changing cortical thickness and synaptic density in response to external stimuli or experiences.[4] Peripheral measurement of BDNF can be correlated with central BDNF levels which is positively related to brain health.[5] Studies revealed that the more BDNF level better the brain health.[4] Level of BDNF increases after practicing healthy lifestyle habits and reduces in various neurological conditions.[6,7] Among all of electronic devices, smartphones are the most popular devices used by the young population.[8] According to a recent study, the prevalence of smartphone addiction is 30% in medical students.[9]

Excessive use of smartphones is an issue raising health-related problems.[10] Smartphone addiction is defined as a technological or behavioral addiction characterized by inability to control excessive usage smartphone leading to negative consequences.[11] Mental distress like anxiety, depression, stress and boredom, loneliness, impaired learning, poor sleep quality, and premature cognitive decline occur as a result of smartphone addiction.[12] The levels of BDNF and their significance have been studied in many neurological conditions like Parkinson's disease, stroke, dementia, and Alzheimer's disease, etc but there is a paucity of literature among mobile addicts.[13] Cognition is an important function of the brain which includes many complex neural processes such as learning, arousal, concentration, attention, memory, and executive functions.[14]

As reviewed by M´endez et al young adults with high smartphone usage are prone to have impaired executive functions indicating an early cognitive decline which is a matter of concern.[15] Smartphone addiction may lead to early cognitive decline due to reduced cognitive stimulation, decreased attention span, impaired memory, sleep disturbances, social isolation, and negative effects of social media.[16]

Excessive use of smartphones replaces mentally stimulating activities, disrupts sleep, and can lead to social withdrawal and mental health issues, all contributing to cognitive decline.[17] Therefore, it is important to focus on the cognitive health of smartphone addicts.

Age and gender differences have been studied extensively in terms of cognition and neuroplasticity which can be attributed to a variety of factors including differences in brain structure and function, hormonal influences, and life experiences.[18,19]

Although, these differences are not absolute and can vary greatly among individuals. Also, Lommatzsch et al stated that age and gender have a specific impact on the circulation of BDNF levels in serum and plasma blood.[20]

These differences may depend on various factors such as hormonal fluctuations, genetic differences, and environmental factors. The previous study suggests that there is a correlation between BDNF levels and cognition but there is limited evidence that states the correlation between BDNF levels and early cognitive decline among young adults.[21]

The cognitive health and process of neuroplasticity need to be studied among young adults of similar age and gender for a better understanding of the effects of excessive smartphone use on cognition and neuroplasticity.

Thus, this study aims to understand the process of neuroplasticity and cognition by comparing age and gender-matched individuals with excessive smartphone use by using BDNF level.

METHODS

Study design

This observational study was conducted in a Health Science Institution with two groups: Mobile and Non-Mobile addicts after obtaining approval from the Research and Ethics committee.

The study was conducted over a period of 6 months from November 2023 to April 2024 at KLE's Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi.

Screening and recruitment

Students and faculty members aged between 18-40 years of both genders of the Institution were screened for mobile addiction using the Short Version of Smartphone Addiction scale (SV-SAS). It is a valid scale includes 10 questions with a 6-points where the scores more than 31 and 33 for male and female respondents were considered mobile addicts respectively.[22]

Inclusion criteria

The inclusion criteria for participants are mobile and non-mobile addicts aged between 18-40 years of both genders diagnosed using SV-SAS who are agreeing for participation.

Exclusion criteria

The exclusion criteria for participants are as follows those with pre-existing neurological conditions, those with known cases of type 1 or 2 diabetes or hypertension, and those with chronic alcoholism and cigarette smoking.

24 participants were recruited in Group A after screening. The other group was formed with 24 age and gender-matched Non-Mobile Addicts who scored less than 31 and 33 in males and females respectively. The voluntary consent was obtained after explaining the purpose of the study to the participants. A total of 48 participants were recruited in the study.

Procedure

Collection of the blood samples from the antecubital vein of each participant was conducted at the hospital attached to the institution. The samples collected were centrifuged at 4000 rpm for 6 minutes. The serum supernatant was stored at -80°C in 0.5 aliquotes after centrifugation within 30 minutes of blood sampling. The time of blood sample collection was between 8 AM and 9 AM in all the individuals examined. The samples stored were tested for BDNF levels using a BDNF GENLISA ELISA Kit at Basic Science Research Center in JNMC Campus, Belagavi.

All the participants were then assessed for cognition using the CogniFit app which is a computer-based gaming application that offers brain training exercises and cognitive assessments. The app tailored training programs based on the individual's cognitive strengths and weaknesses, as assessed through various tasks and assessments.

It includes cognitive assessment, personalized training, brain training games, and progress tracking. An initial cognitive assessment was taken by all the participants. The test included 10 tests that evaluated reasoning, memory, attention, coordination, and perception. The results of each group were collected. The results of BDNF levels and cognition scores were compared in age and gender-matched mobile and non-mobile addicts.

Outcome measures

BDNF levels

BDNF is a neurotrophin that helps in neuronal survival, neurogenesis, synaptogenesis, and neuroplasticity. A greater level of BDNF shows better brain health. It is been reported that serum and cortical BDNF levels are positively correlated as BDNF can cross the blood-brain barrier. Therefore, serum and plasma BDNF measurement can indicate the central BDNF levels.

Cognition scores

To check the cognition a game-based app named CogniFit is used which has Cronbach's Alpha value above 7. The cognitive score is measurement of the present cognitive strength of various cognitive abilities.

The cognitive score ranges from 0 to 800. A scores 0–200 are below the average considering age. Scores 200–400 are low scores within the average. Scores 400–600 are high scores within the average. Scores 600–800 are Cognitive situations above the average.

Statistical analysis

Collected data was analyzed using version 23 of SPSS software. Demographic characteristics were described using Descriptive Statistics. A normality check was done for all the variables using the Shapiro-Wilk Test. The cognitive scores of group A and group B were compared using the independent sample "t" test. BDNF levels of group A and group B were compared using the Mann-Whitney "U" test. The significance level for all variables was p value <0.05.

RESULTS

Table 1 shows demographic details of participant included in the study. Majority of participants in both groups were females in age group of 21-25 years. The mean SAS-SV score of males in group A was 41 and females 41.

Thus, the participants in group A can be categorized as mobile addicts whereas group B can be categorized as non-mobile addicts. The mean of the number of years of mobile usage of participants in group A 8 and group B 6. The mean of hours spent using phone per day for group A and Group B was 6 and 4 respectively. Maximum participants in both the groups prefer using mobiles for personal leisure activities.
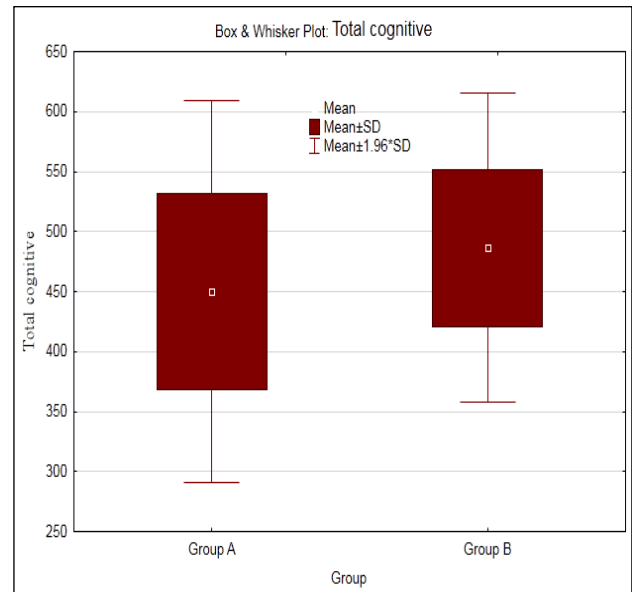

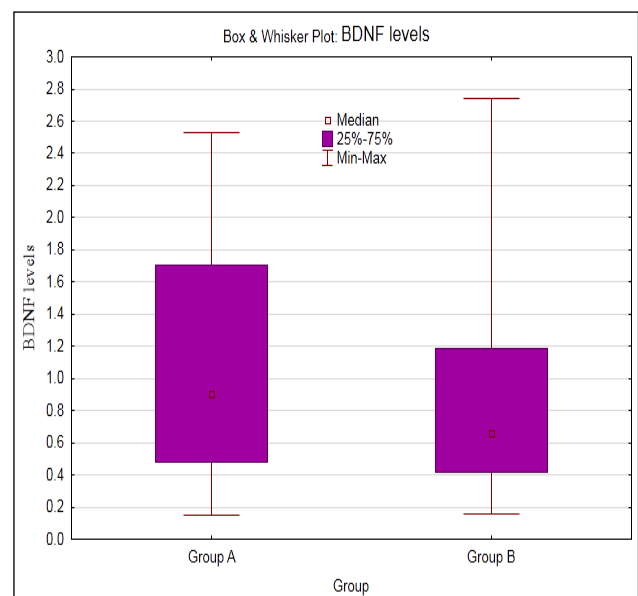**Figure 1: Comparison of group A and group B with cognitive scores.**

Figure 2: Comparison of group A and group B with BDNF levels.

Table 3 and Figure 2 shows the comparison of BDNF levels between group A and group B. The p value of difference between two groups is 0.4897 which depicts that there is no statistically significant difference in the

BDNF levels of participants in both the groups. The Table 2 and Figure 1 shows comparison in between group A and B with total cognitive scores. The p value is 0.0971 which is non-significant. The results indicate there is no difference in statistical significance in the Cognition performances of participants of both groups (p=0.0971).

Table 1: Demographic characteristics of participants.

Characteristics		Group A (n=24)	Group B (n=24)
Age (in years)	≤20	6	6
	21-25	15	15
	≥26	3	3
Gender	Male	6	6
	Female	18	18
SAS-SV	Male	41*	24*
	Female	41*	24*
Years of mobile usage		8*	6*
Hours/ day		6*	4*
Work related usage		8	13
Personal usage		16	11

(*Values in mean)

Table 2: Comparison of cognitive scores Group A and Group B.

Group	Mean	SD	t value	P value	Mean diff.	95% CI for mean diff.	
						Lower	Upper
Group A	450.08	81.40					
Group B	486.25	65.71	-1.6937	0.0971	-36.17	-79.15	6.82

*p<0.05

Table 3: Comparison of BDNF levels of Group A and Group B.

Group	Mean	SD	Mean rank	Z value	P value	Mean Diff.	95% CI for Mean Diff.	
							Lower	Upper
Group A	1.06	0.76	25.92					
Group B	0.89	0.66	23.08	0.6908	0.4897	0.18	-0.24	0.59

DISCUSSION

This focus of the study was to investigate the impact of mobile addiction on neuroplasticity and cognition in mobile addicts. The process of neuroplasticity was assessed using levels of BDNF and cognition was assessed using the CogniFit app. The values of BDNF and cognition scores were compared in age and gender-matched mobile addicts and non-mobile addicts. The finding of the study suggests that cognition scores and levels of BDNF between mobile addicts and non-mobile addicts show no statistically significant difference.

The neurotrophins BDNF mediates cellular processes required for the development and preservation of normal brain function by interacting and stimulating the TrkB.[23] BDNF enhances synaptic strength either by increasing release of pre-synaptic transmitter or by improving post-synaptic sensitivity, resulting in increase in synaptic plasticity.[24] As suggested by Buchman et.al, higher levels of BDNF are associated with better cognition.[25]

There has been curiosity in recent years to study the impact of mobile phone addiction on cognition of the individuals due to the rise in its over-usage with advancing technologies and demand. It is believed that Mobile addicts tend to have impaired executive functions such as reactive thinking, planning, self-regulation, self-control, memory, managing time, and organization that affect levels of BDNF.[26] However, several other factors have to be considered while stating the absolute correlation.

Previous research on smartphone addiction suggests that anxiety and depression are most prevalent psychological issues among smartphone addicts.[27] Stress and depression also contribute to negative neuroplastic change by reducing the BDNF level.[28] Our study did not take into consideration the stress, anxiety, and depression factors in both groups. This could the reason for the lack of a difference in statistical significance between the two groups' BDNF levels.

Erikson et al discovered a correlation between aging and decreased BDNF levels, which in turn was linked to a decline in hippocampus volume and an increase in

memory impairments.[29] Postmortem findings of the same study concluded that hippocampal BDNF levels are reduced in elderly than younger adults suggesting that circulating levels of BDNF decrease with age.[29] According to a study by Murman et al normal aging is related to cognitive changes. Age-related declines occur in several areas of cognition such as language, executive function, attention, memory, and visuospatial skills.[30] As in our study, we have studied the levels of BDNF and cognition in age and gender matched individuals to eliminate the factors affecting neuroplasticity and cognition, both the groups showed similar processes of neuroplasticity and cognition.

According to research by Thomas et al, there is no correlation between the amount of time spent using a mobile device and cognition. Instead, the observations of the study demonstrated that after 1 year follow up the participants with longer exposure became faster.[31] The authors suggest that this could be because of practice effects. Similarly, in our study, levels of BDNF and cognition showed no statistically significant difference, as the levels of BDNF and cognition scores were higher in mobile addicts. This could be due to the practice effects of continuous smartphone use.

The study has several limitations firstly; this study did not include different types and duration of Mobile addiction. Secondly, the factors that influence the process of neuroplasticity and cognition such as stress level, lifestyle, and eating habits of each of the participants were not considered. Therefore, studies that address the above limitations are required in the future.

CONCLUSION

According to the findings no statistical difference is seen in the levels of BDNF and cognition scores of both groups. Therefore, it can be concluded that there is no difference in the process of neuroplasticity and cognitive performances in age and gender matched mobile addicts and non-mobile addicts.

REFERENCES

1. Puderbaugh M, Emmady PD. Neuroplasticity. In: StatPearls. Treasure Island (FL): StatPearls. Available at: http://www.ncbi.nlm.nih.gov/books; 2002.
2. Naegelin Y, Dingsdale H, Säuberli K, Schädelin S, Kappos L, Barde YA. Measuring and Validating the Levels of Brain-Derived Neurotrophic Factor in Human Serum. Neuro. 2018;5(2):419.
3. Wlodarczyk L, Szelenberger R, Cichon N, Saluk-Bijak J, Bijak M, Miller E. Biomarkers of Angiogenesis and Neuroplasticity as Promising Clinical Tools for Stroke Recovery Evaluation. Int J Mol Sci. 2021;22(8):3949.
4. Dou SH, Cui Y, Huang SM, Zhang B. The role of brain-derived neurotrophic factor signalling in central nervous system disease pathogenesis. Front Hum Neurosci. 2022;16:924155.
5. Chan KL, Tong KY, Yip SP. Relationship of serum brain-derived neurotrophic factor (BDNF) and health-related lifestyle in healthy human subjects. Neurosci Lett. 2008;447(3):124–8.
6. Håkansson K, Ledreux A, Daffner K, Terjestam Y, Bergman P, Carlsson R, et al. BDNF Responses in Healthy Older Persons to 35 Minutes of Physical Exercis Cognitive Training, and Mindfulness: Associations with Working Memory Function J Alzheimers Dis JAD. 2017;55(2):645–57.
7. Reid LB, Pagnozzi AM, Fiori S, Boyd RN, Dowson N, Rose SE. Measuring neuroplasticity associated with cerebral palsy rehabilitation: An MRI based power analysis. Int J Dev Neurosci Off J Int Soc Dev Neurosci. 2017;58:17–25.
8. Vezzoli M, Colombo A, Marano A, Zoccatelli G, Zogmaister C. Test for Mobile phone dependence: psychometric properties and confirmatory factor analysis Psychol. 2023;42(1):714–25.
9. Gangadharan N, Borle AL, Basu S. Mobile phone addiction as an emerging behavioral form of addiction among adolescents in India. Cureus. 2021;14(4):23798.
10. Wilmer HH, Sherman LE, Chein JM. Smartphones and cognition: a review of research exploring the links between mobile technology habits and cognitive functioning. Front Psychol. 2017;8:605.
11. Davey S, Davey A. Assessment of Smartphone Addiction in Indian Adolescents: A Mixed Method Study by Systematic-review and Meta-analysis Approach. Int J Prev Med. 2014;5(12):1500–11.
12. Ratan ZA, Parrish AM, Zaman SB, Alotaibi MS, Hosseinzadeh H. Smartphone addiction and associated health outcomes in adult populations: a systematic review. Int J Environ Res Public Health. 2021;18(22):12257.
13. Vezzoli M, Colombo A, Marano A, Zoccatelli G, Zogmaister C. Test for Mobile phone dependence: psychometric properties and confirmatory factor analysis. Current Psychol. 2021;13:1-2.
14. Mahajan A, Gokhale PD. Core Strengthening Exercises for Improving Static and Dynamic Sitting Balance in Persons with Spinal Cord Injury: A Pilot Study. J Soc Indian Physiotherap. 2025:10-4103.
15. León Méndez M, Padrón I, Fumero A, Marrero RJ. Effects of internet and smartphone addiction on cognitive control in adolescents and young adults: A systematic review of fMRI studies. Neurosci Biobehav Rev. 2024;159:105572.
16. Teixeira AL, Barbosa IG, Diniz BS, Kummer A. Circulating levels of brain- derived neurotrophic factor: correlation with mood, cognition and motor function. Biomark Med. 2010;4(6):871–87.

17. Chen B, Liu F, Ding S, Ying X, Wang L, Wen Y. Gender differences in factors associated with smartphone addiction: a cross-sectional study among medical college students. BMC Psych. 2017;17(1):341.
18. Lommatzsch M, Zingler D, Schuhbaeck K, Schloetcke K, Zingler C, Schuff-Werner P, et al. The impact of age, weight and gender on BDNF levels in human platelets and plasma. Neurobiol Aging. 2005;26(1):115–23.
19. Kwon M, Kim DJ, Cho H, Yang S. The smartphone addiction scale: development and validation of a short version for adolescents. PLoS One. 2013;8(12):83558.
20. Bathina S, Das UN. Brain-derived neurotrophic factor and its clinical implications. Arch Med Sci. 2015;11(6):1164–78.
21. Yue H, Yue X, Liu B, Li X, Dong Y, Bao H. Short version of the smartphone addiction scale: Measurement invariance across gender. PLOS ONE. 2023;18(3):283256.
22. Salthouse TA. When does age-related cognitive decline begin. Neurobiol Aging. 2009;30(4):507–14.
23. Colucci-D'Amato L, Speranza L, Volpicelli F. Neurotrophic factor BDNF, physiological functions and therapeutic potential in depression, neurodegeneration and brain cancer. IJMS. 2020;21(20):7777.
24. Miranda M, Morici JF, Zanoni MB, Bekinschtein P. Brain-derived neurotrophic factor: a key molecule for memory in the healthy and the pathological brain. Front Cell Neurosci. 2019;13:363.
25. Buchman AS, Yu L, Boyle PA, Schneider JA, De Jager PL, Bennett DA. Higher brain BDNF gene expression is associated with slower cognitive decline in older adults. Neurol. 2016;86(8):735-41.
26. Zhang Y, Shang S, Tian L, Zhu L, Zhang W. The association between fear of missing out and mobile phone addiction: a meta-analysis. BMC Psychol. 2023;11(1):338.
27. Ratan ZA, Parrish AM, Zaman SB, Alotaibi MS, Hosseinzadeh H. Smartphone addiction and associated health outcomes in adult populations: a systematic review. Int J Environ Res Public Health. 2021;18(22):12257.
28. Chakrapani S, Eskander N, De Los Santos LA, Omisore BA, Mostafa JA. Neuroplasticity and the Biological Role of Brain Derived Neurotrophic Factor in the Pathophysiology and Management of Depression. Cureus. 202112(11):11396.
29. Erickson KI, Prakash RS, Voss MW, Chaddock L, Heo S, McLaren M, Pence BD, Martin SA, Vieira VJ, Woods JA, McAuley E. Brain-derived neurotrophic factor is associated with age-related decline in hippocampal volume. J Neurosci. 2010;30(15):5368-75.
30. Murman DL. The impact of age on cognition. Semin Hear. 2015;36(3):111–21
31. Thomas S, Benke G, Dimitriadis C, Inyang I, Sim MR, Wolfe R, Croft RJ, Abramson MJ. Use of mobile phones and changes in cognitive function in adolescents. Occup Environ Med. 2010;67(12):861-6.