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# Study of Cognitive Functioning Among Smart Phone Users and Its Correlation with Loneliness

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Abstract:

The digital era has exerted a profound influence on everyday life, offering convenience but also fostering addictive behaviors. The constant compulsion to check digital devices induces stress and cultivates a captivating, almost compulsive, behavior among individuals. This cascade effect perpetuates a state of constant activity, leaving little room for rest or mindfulness. While digital devices enhance awareness and connectivity, their excessive use is associated with a range of detrimental health effects, including cognitive impairments, musculoskeletal issues, and restlessness. These consequences result in a disconnection from the present, leading to a diminished sense of spatial and temporal orientation. To evaluate the cognitive decline linked to excessive smartphone usage, this paper proposes the use of cognitive assessments such as the Addenbrooke's Cognitive Examination (ACE-III), focusing on domains such as attention, memory, verbal fluency, language, and visuospatial abilities. The study aims to explore the extent of cognitive deterioration caused by smartphone overuse and offer insights into potential strategies to mitigate these negative effects.

Keywords:

Cognitive Function, Psychological impairments, Musculoskeletal impairments, Digital impacts, Restlessness.

## Introduction:

The use of smartphones is a necessity now instead of a choice. The innovation of phones and various software has made our lives more convenient. However, the negative effects of our excessive dependence on them cannot be ignored [1-2]. Around the world, smartphones were

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used by 1.85 billion people in 2014 which was expected to be 2.32 billion in 2017 and 2.87 billion in 2022. Mobile phones make our lives easier, but on the other hand, it ties us. Mobile addiction not only has physical effects but also psychological and academics effect at the same time. Sleep deficit, anxiety, stress, and depression which are all associated with internet abuse, have been related to mobile phone usage too[(3)].

Many recent studies have explained the relationship between smartphones and cognitive functions and have argued that the dependence on smartphones may increase anxiety and negatively affect cognitive functions [(4-6)].

The main factors predicting excessive smartphone use were being female, preoccupation, conflict, and use for ubiquitous trait whereas the protective factor was use for learning [(4).]Excessive use of smartphones was correlated with impairment in the function of the family and relationship with friends, impulsiveness, and low self-esteem in South Korean adolescents[(5)]. Finally, smartphone gaming was associated with excessive smartphone use among adolescents[(6)].

Excessive use of smartphone paired with negative attitude and feeling of anxiety and dependency on gadgets may increase the risk of anxiety and depression. A survey about Elon Students' behaviour along with an online survey found that students seemed to be addicted to their mobile phones[(6)].Another observational study reports that insomnia may lead to depression. Li et al. (2016) did a prospective cohort and proposed that insomnia and risk of depression are associated. DeSola Gutiérrez et al. (2016) revealed that the problematic cell phone usage had been associated with sleep deficit, depression, anxiety, and stress. Cha and Seo (2018) aimed to examine the predictive factors of smartphone addiction in middle school students in South Korea. Two groups were chosen, one risk group and another normal group. The two groups expressed significantly different results. The predictive factors for smart phone addiction were social networking and awareness of game overuse. A researcher revealed that teenagers who spend more hours on their gadgets are highly likely more at risk of suicide. Another study by Augner and Hacker (2012) examined an association between over usage or dysfunctional usage of cell phones and psychological health. They indicated that low emotional

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stability, chronic stress, and depression have a correlation with phone usage. According to latest studies, it is come to know that there are two schools of thoughts. Some researchers believe that there is a positive association between cell phone addiction and the mental health of adolescence and some believe that there is a negative or indirect relation in them.[5-7]

Some authors argue that smartphones should be used in university contexts as a teaching tool in order to optimize performance, employing an approach known as m-learning, mobile learning, or mobile-assisted learning, provided that students are taught to use them approximately[6].Sanbonmatsu, Strayer, Medeiros-Ward, and Watson[7] studied multitasking skills to assess motivation toward smartphone use in 310 students. They found that participants presenting higher levels of benefit- or reward-based motivation and weak avoidance behavior (with high levels of impulsivity and sensation-seeking) reported greater multitasking behavior. In addition, participants with less executive control (greater impulsivity) tended to present higher levels of multitasking behavior, preventingthem from focusing on the target behavior. In a sample of 1,301 students at the University of Madrid,

Muñoz-Rivas, Fernández, and Gámez-Guadix [8] observed that abusive internet use via various technologies including smartphones—correlated significantly with disruptive personality factors. Those who made most use of mobile devices presented greater loss of control, changes in health habits, and behaviour that was often conditioned by negative reinforces. Another study found that appropriate smartphone use correlated positively with self-esteem[9] and increased perceived self-efficacy([10],creativity[11], and [motivation(12)]. In addition, Choi, Song, and Oh[13]observed that smartphone addiction correlated with low emotional intelligence (EI) and detected a negative correlation between the variable of tolerance–withdrawal and EI, whereby the lower the smartphone tolerance, the higher the EI, and vice versa.

Several previous studies observed that mobile phone use has potential to affect cognition. Thornton et al reported that mere presence of a cell phone results in diminished attention and worsen task performance[7]. Poorer working memory was exhibited in studies by Cain et al and Uncapher et al in case of frequent media multitaskers.[8,9] Lepp et al demonstrated negative correlation between smartphone usage and academic performance[10]. Furthermore, even brain

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imaging studies reported that associated cognitive deficit may be directly manifest in the functioning of the brain's corresponding control circuitry. Loh and Kanai found reduced grey matter in the anterior cingulate cortex of frequent media multitaskers, indicating that this habit may have a direct impact on the structural properties of an important locus of attentional control in the brain[(11)]. Based on previously available literature, it can be surmised that various other domains of cognition could also be negatively affected with smartphone usage. However, there is limited literature available to show definite cognitive decline with respect to different domains of cognition and a global cognitive decline associated with smartphone usage. Therefore, this study looks forward to study levels of cognitive decline with smartphone usage.

Cognitive abilities can be assessed under 5 domains which includes Attention, Memory, Verbal fluency, Language, Visuospatial abilities. To assess cognitive function of any individual, cognitions tests are designed specifically. These tests involve the systematic administration of clearly defined procedures. They are also used for clinical and neurological research. This study aims to use Addenbrooke's Cognition Examination (ACE-III) as a tool to assess cognitive levels.

Methods:

Study design- observational study.

Data Extraction- the articles are searched from online free assess journals focusing on cognitive and physiological impacts following excessive digital device usage.

Study setting- The present study was conducted in Department of Physiology, Pacific Medical College & Hospital, Udaipur after taking approval from Institutional Ethics Committee. A written informed consent was obtained from all participants.100 subjects were recruited and categorised as per the duration of smart phone use.The Smartphone usage was determined by self-reporting or scale PRIUSS. Addenbrooke's Cognition Examination (ACE-III) was administered for assessing cognition functioning of each participant.

Inclusion criteria-

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- Age between 18-50 years
- Both male and female
- Minimum SSC pass
- Smartphone users

Exclusion criteria-

- Diagnosed cases of neurological or psychiatric disorders.
- Patients taking medications which are known to affect cognition.
- Presence of any medical psychiatric disorder.
- History of severe head injury.

Results:

| | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| PRIUSS Scale score | 5 | 59 | 26.31 | 10.668 |
| DASS Scale score | 2 | 36 | 16.90 | 9.134 |
| Total ACE III Score | 55 | 100 | 82.32 | 14.358 |
| Attention | 6 | 19 | 14.05 | 3.574 |
| Memory | 14 | 26 | 21.81 | 3.730 |
| Fluency | 7 | 14 | 11.71 | 2.138 |
| Language | 12 | 26 | 21.32 | 3.915 |
| Visuospatial | 9 | 16 | 13.43 | 1.955 |

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Table 1: Mean characteristics of smartphone users (n = 100).

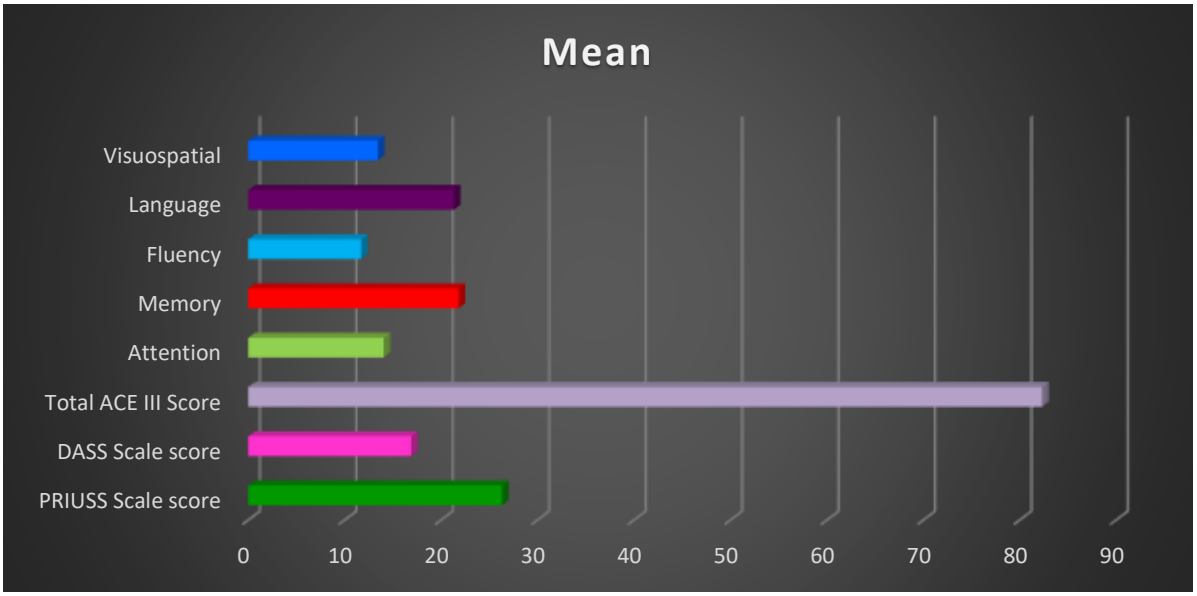


Figure 1: Mean characteristics of smartphone users.

Table 1 and figure 1 represents the mean characteristics of 100 smartphone users. The minimum PRIUSS scale score and DASS scale score were found to be 5 and 2 respectively, with maximum observed score of 59 and 36 respectively. Maximum observed score in Total ACE-III was found to be 100 which is also the maximum score that can be observed in standard ACE-III total score, with minimum observed score as 55. The maximum and minimum scores for each domain of cognition are also mentioned in the Table 1 and Figure 1. Table 1 also represent values for mean with standard deviation for each component.

**Table 2: Correlation between PRIUSS scale and DASS scale and ACE III Score.**

| PRIUSS scale | R | p-value |
|---|---|---|
| DASS scale | 0.753 | 0.001 |
| ACE III Score | -0.697 | 0.001 |

r=Pearson's correlation, p <0.05 Significant

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**Figure 2A: Scatterplots showing the correlation between PRIUSS scale and DASS scale.**

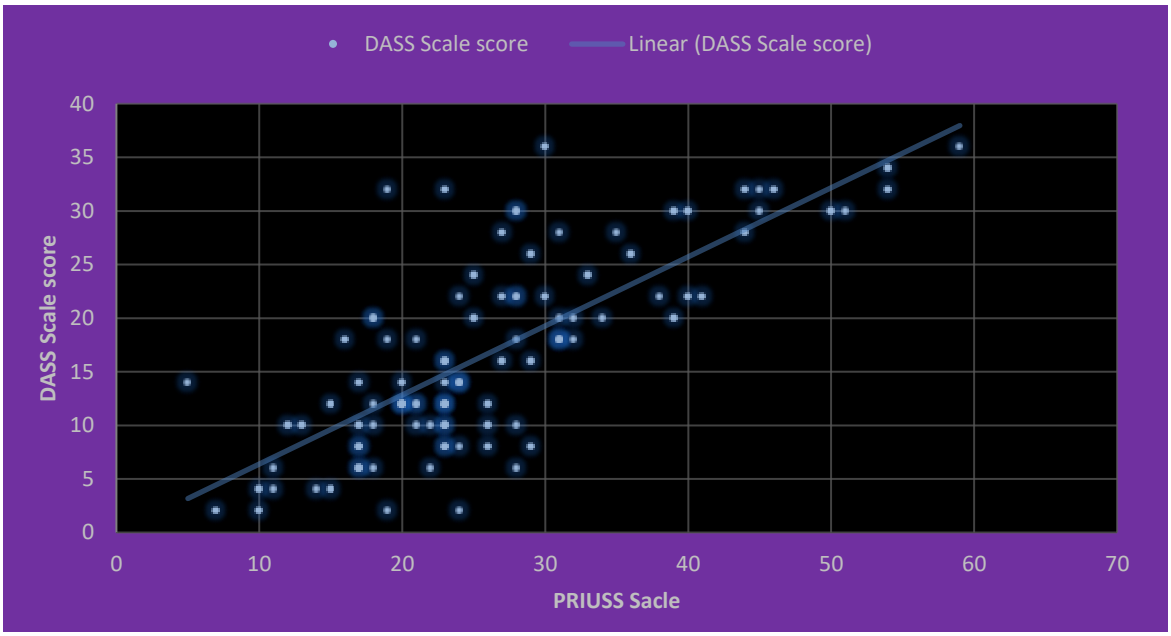

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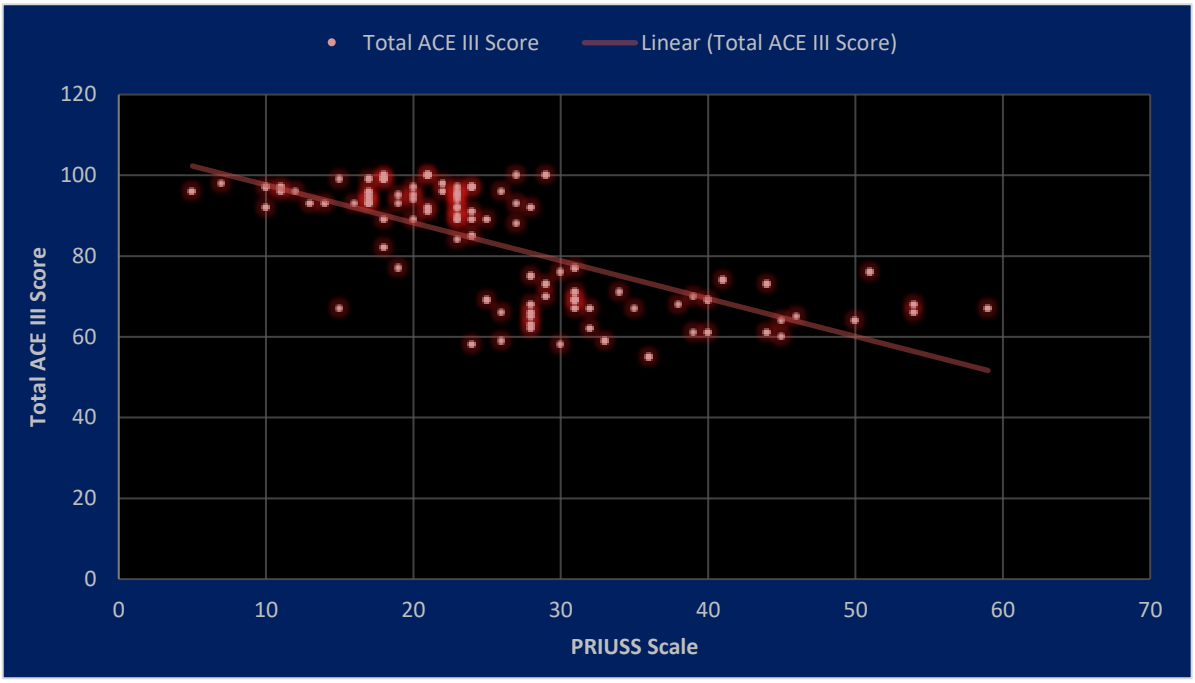
**Figure 2B: Scatterplots showing the correlation between PRIUSS scale and ACE III Score**




**Interpretation:**

Based on the results, we can state the following:

PRIUSS scale and DASS scale have a statistically significant linear relationship ($r$=0.753, $p$=0.001).

The direction of the relationship is positive (i.e., PRIUSS scale and DASS scale are positively correlated), meaning that these variables tend to increase together.

PRIUSS scale and ACE III score have a statistically significant linear relationship ($r$=-0.697, $p$=0.001).

The direction of the relationship is negative (i.e., PRIUSS scale and ACE III score are negatively correlated), meaning that if PRIUSS scale increases ACE III score decreases.

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**Table 3: Correlation between PRIUSS scale and Attention, Memory, Fluency, Language and Visuospatial.**

| PRIUSS scale | R | p-value |
|---|---|---|
| Attention | -0.745 | 0.001 |
| Memory | -0.657 | 0.001 |
| Fluency | -0.606 | 0.001 |
| Language | -0.635 | 0.001 |
| Visuospatial | -0.566 | 0.001 |

r=Pearson's correlation, p <0.05 Significant

**Figure 3A: Scatterplots showing the correlation between PRIUSS scale and Attention.**

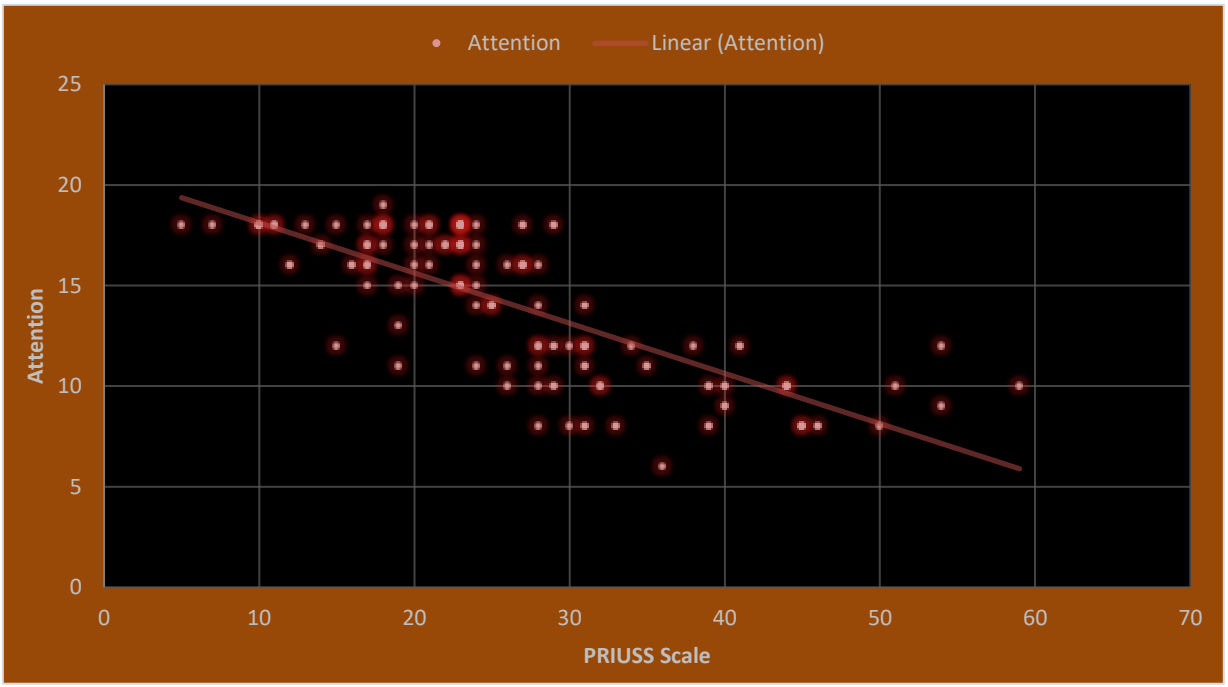

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**Figure 3B: Scatterplots showing the correlation between PRIUSS scale and Memory.**


**Figure 3C: Scatterplots showing the correlation between PRIUSS scale and Fluency.**

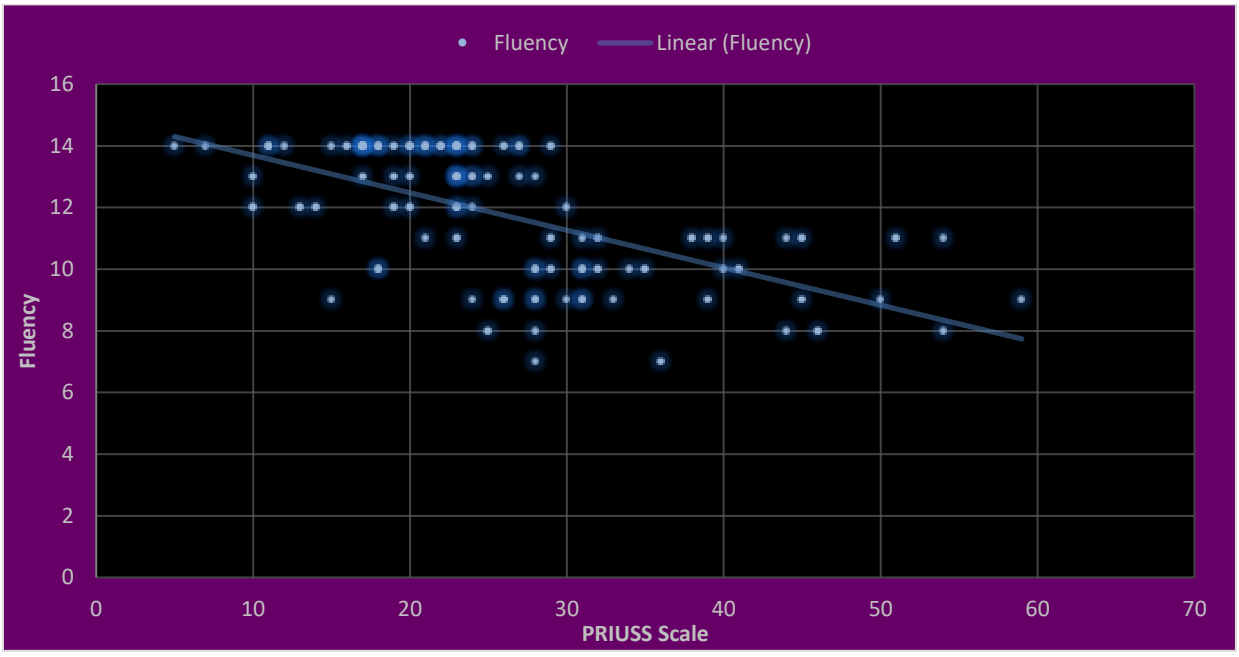

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**Figure 3D: Scatterplots showing the correlation between PRIUSS scale and Language.**

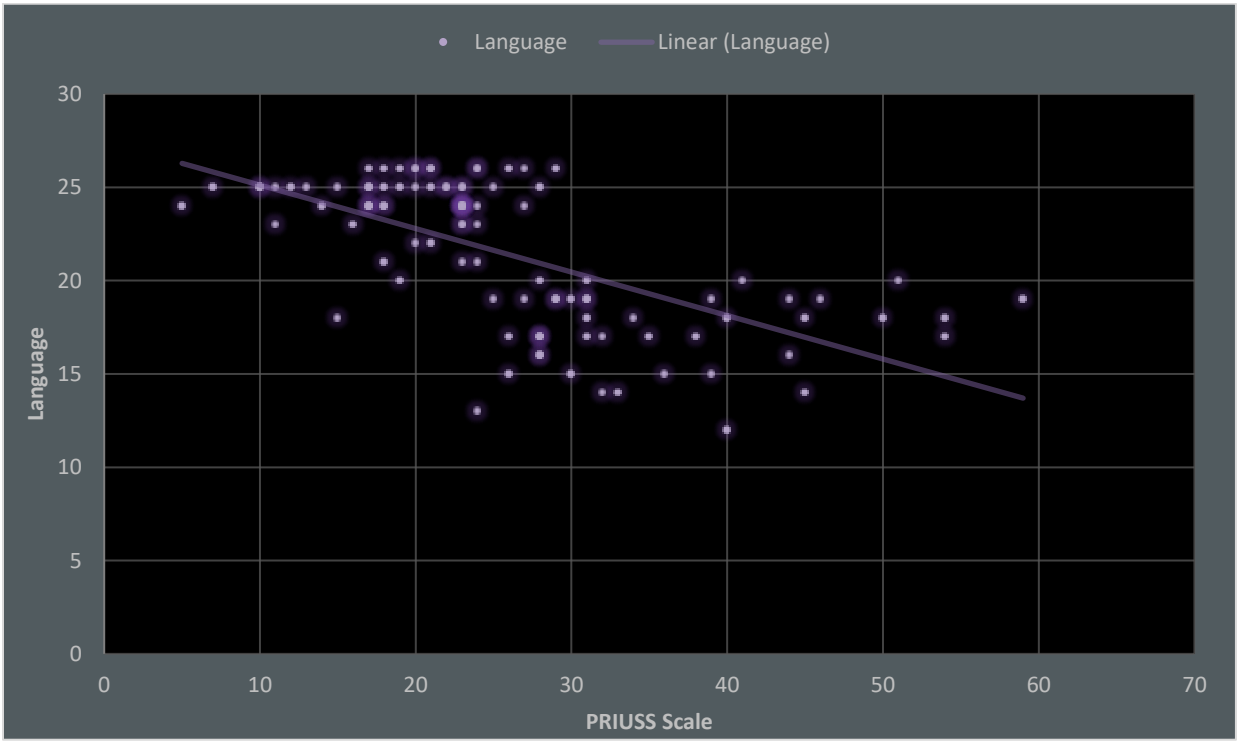

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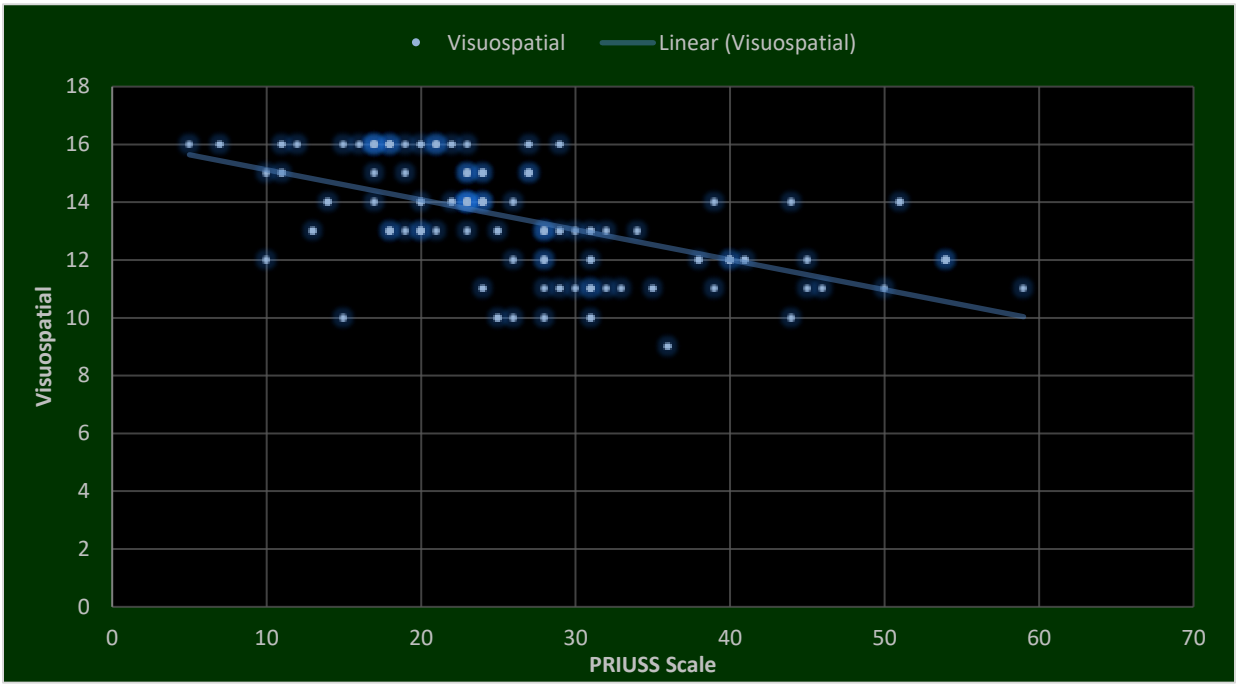
**Figure 3E: Scatterplots showing the correlation between PRIUSS scale and Visuospatial.**




**Interpretation:**

Based on the results, we can state the following:

PRIUSS scale and Attention, Memory, Fluency, Language and Visuospatial have a statistically significant linear relationship (*p*=0.001).

The direction of the relationship is negative (i.e., PRIUSS scale and Attention, Memory, Fluency, Language and Visuospatial are negatively correlated), meaning that if PRIUSS scale increases and Attention, Memory, Fluency, Language and Visuospatial decreases.

**Table 4: Model of multiple linear regression analysis of the variables of smartphone addiction (PRIUSS scale) and DASS scale.**

| **DASS Scale** ($r^2$ = 0.566) | | | | | |
|---|---|---|---|---|---|
| | B | 95% CI | Beta | Std. Error | p-value |

| | | Lower Bound | Upper Bound | | | |
|---|---|---|---|---|---|---|
| PRIUSS Scale | 0.644 | 0.531 | 0.757 | 0.753 | 0.057 | 0.001 |

**Interpretation**: Problems caused by excessive smartphone use were significantly related to severity of loneliness (p=0.001).

Discussion:

The present study evaluated cognitive domain levels across 100 smart phone users and the change in cognitive domain levels was observed with the smartphone use. This study also assessed severity of loneliness perceived in each subject and then correlated with the use of smartphone use and levels of cognitive domains. The Smartphone usage was determined by the scale PRIUSS whereas DASS scale was used for the perceived loneliness in the subjects. Addenbrooke's Cognitive Examination (ACE-III) was administered for assessing cognitive domain levels of each subject.

The results revealed that the subjects with more smartphone use experienced greater decline in all the cognitive domain levels and also the overall cognitive decline reported as total ACE-III score. Our finding is in line with the study done by Tze Pin Ng et al.[15]who found decline in global cognitive, attention and working memory, memory functioning with more frequent use of mobile phones. The study specifically evaluated cognitive function in attention and memory domain and found that there is a decline in both these with the use of smartphone. This finding follows studies by various researchers[18,29,32,60,61] which examined the cognitive decline with the greater use of smartphone and found a significant association between them.

Majority of the previous researchers either used one or two domains of cognition whereas our study assessed major 5 domains of cognition with an overall global cognitive level. The present study is unique in the aspect that the decline in cognitive decline has been well assessed with the smartphone use with the major cognitive domains, which could be helpful in the prompt diagnosis of smartphone related cognitive problems that is encountered with its users.

Caplan et al.[54] in their study observed that lonely and socially isolated people feel a sense of relief when participating in the world of virtual reality. Loneliness in individuals make them prone to

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the use of mobile phones and other media. The study using DASS scale evaluated the level of loneliness in the subjects and found that the smartphone use and higher DASS score have a significantly linear relationship ($r$=0.753,$p$ = 0.001). We also observed the direction of relationship is positive which implies that these tend to increase together. One study[58] by Morikawa et al investigated the influence of social isolation and smartphone use on cognitive functions in adults and found that smartphone use was associated with cognitive functions (memory, attention, executive function, and processing speed).The current study also found decline in cognitive functions decline with the severity of loneliness in the subjects. Furthermore, we also assessed individual levels and reported decline in all the domains of cognition.

Conclusion:

The use of smartphones in our daily life is crucial but brings with it a variety of adverse effects too. One major adverse effect among them is a decline in our cognitive abilities. The use of smartphone has been increasing day by day for to help us in our work and family life, but with the increasing stress and loneliness, people are inclined more towards its use. This study was aimed at evaluating change in cognitive decline with the smartphone use and finding correlation between loneliness and smartphone use. This study reports there is decline in cognitive levels with smartphone use and it is correlated with the loneliness too.

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