RESEARCH PAPER

# Assessment Of Cognitive Decline And Effect Of Multicomponent Exercises Among Young Adults Using Smartphones


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## ABSTRACT

**Background:** Excessive smartphone use has become increasingly common among young adults and is linked to impairments in attention, executive function, processing speed, cognitive flexibility, and working memory. Nevertheless, the evidence regarding the prevalence of cognitive decline associated with smartphone use and the effectiveness of multicomponent exercise in enhancing cognitive function is still limited.

**Aims:** To assess the prevalence of cognitive decline in young adult smartphone users, examine the relationship between smartphone addiction and cognitive decline, and evaluate the impact of an 8-week multicomponent exercise program on cognitive function.

**Methods:** A quasi-experimental study was carried out involving 316 young adults aged 18 to 25 years. Smartphone addiction was evaluated using the Smartphone Addiction Scale–Short Version (SAS-SV), while cognitive function was assessed through the Trail Making Test Part A (TMT-A), Trail Making Test Part B (TMT-B), and the Two-Back Task. Participants experiencing cognitive decline engaged in an 8-week multicomponent exercise program, consisting of four sessions per week. Data were analysed utilising descriptive statistics, Pearson's Chi-square test, binary logistic regression, and paired *t*-test.

**Results:** Smartphone addiction was observed in 118 participants, accounting for 37.3%, whereas 121 participants, representing 38.3%, exhibited cognitive decline. Smartphone addiction demonstrated a significant correlation with cognitive decline ($\chi^2 = 92.35$, *p* < 0.001), indicating that individuals with addiction exhibited 11.59 times greater odds of experiencing cognitive decline (OR = 11.59; 95% CI: 6.75–19.90). Following the intervention, notable enhancements were recorded in TMT-A, TMT-B, and Two-Back Task scores (*p* < 0.001), reflecting improvements in attention, processing speed, executive function, cognitive flexibility, and working memory.

**Conclusion:** Smartphone addiction is closely linked to cognitive decline in young adults. An 8-week multicomponent exercise program significantly enhanced cognitive performance and may act as an effective physiotherapy intervention for the prevention and management of smartphone-associated cognitive decline.



**Keywords:** Smartphone addiction; Cognitive decline; Multicomponent exercise; Trail Making Test; Two-Back Task; Young adults.

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## INTRODUCTION

Smartphones have become essential in contemporary life, especially among young adults, due to their widespread application in education, communication, entertainment, and social networking. While smartphones provide various benefits, their excessive and uncontrolled use has become a notable public health issue. Smartphone addiction is defined by an uncontrollable urge to use smartphones, even in the face of negative physical, psychological, and social effects. Recent studies indicate that around 25% of young adults demonstrate problematic smartphone use, with an even greater prevalence observed among college students in India.[1–3]

Increasing evidence indicates that excessive smartphone use negatively impacts various cognitive domains, such as attention, processing speed, executive function, cognitive flexibility, and working memory. Continuous exposure to digital notifications, multitasking, prolonged screen time, and excessive social media engagement can result in cognitive overload, attentional fragmentation, and impaired executive control, ultimately diminishing academic performance and overall quality of life.[4–6] Standardised neuropsychological assessments such as the Trail Making Test (TMT) Parts A and B and the 2-Back Task serve as reliable, objective, and sensitive instruments for evaluating cognitive domains in healthy young adults.[7–9]

Consistent engagement in physical activity has demonstrated a positive impact on cognitive performance through the enhancement of cerebral blood flow, the promotion of neuroplasticity, and the stimulation of neurotrophic factors that play a crucial role in learning and memory. Among various exercise modalities, multicomponent exercise, which combines aerobic, resistance, balance, coordination, agility, and cognitively challenging tasks, has shown significant benefits for enhancing attention, executive function, processing speed, and working memory.[10–12] However, evidence concerning the prevalence of cognitive decline associated with smartphones and the efficacy of multicomponent exercise in reversing these deficits, especially among young adults in India, remains limited.

Consequently, this study seeks to evaluate the prevalence of cognitive decline in young adults who use smartphones, investigate the relationship between smartphone addiction and cognitive decline, and assess the impact of an eight-week multicomponent exercise program on enhancing cognitive function. The findings are anticipated to offer evidence for the early identification of cognitive impairment related to smartphone use and to support physiotherapy-based interventions aimed at enhancing cognitive health in young adults.

## MATERIALS & METHODS

**Study Design:** A quasi-experimental study was carried out to ascertain the prevalence of cognitive decline among young adults who use smartphones, examine the relationship between smartphone addiction and cognitive decline, and evaluate the impact of an 8-week multicomponent exercise program on cognitive function.# Ethical Approval The study protocol received approval from the Institutional Ethics Committee of GSL Medical College & General Hospital. Informed consent was secured from all participants before enrollment, and confidentiality was upheld throughout the duration of the study.

**Study Setting and Duration**: The study was carried out in the Department of Physiotherapy at tertiary care teaching institutions associated with Dr NTR University of Health Sciences from July 2025 to June 2026. The intervention programme was conducted over a duration of eight weeks, comprising four supervised sessions each week.

**Study Population and Sample Size:** Young adults aged 18–25 years who regularly utilised smartphones were recruited through a method of simple random sampling. The minimum sample size was determined using the single population proportion formula, based on an expected prevalence of 25%, resulting in a necessary sample of 202 participants. To enhance accuracy and address non-response, 346 individuals were approached, 316 participants completed the baseline assessment, and 121 participants meeting the criteria for cognitive decline were included in the intervention phase.

**Inclusion Criteria:** Individuals in the age range of 18 to 25 years. Regular users of smartphones. Participants exhibiting smartphone addiction were identified utilising the Smartphone Addiction Scale–Short Version (SAS-SV). Participants exhibiting cognitive decline are identified byTMT-A >35 seconds, TMT-B >75 seconds, or 2-Back task accuracy <85%. Individuals who are prepared to give written informed consent.

**Exclusion Criteria:** Individuals with neurological or psychiatric disorders, visual, auditory, or speech impairments, medical conditions that contraindicate exercise, those engaged in structured cognitive or exercise training, and participants who declined to take part were excluded.

**Outcome Measures:** Smartphone addiction was evaluated utilising the Smartphone Addiction Scale–Short Version (SAS-SV). Cognitive function was assessed utilising the Trail Making Test Part A (TMT-A) to measure attention and processing speed, the Trail Making Test Part B (TMT-B) to evaluate executive function and cognitive flexibility, and the 2-Back Task to examine working memory and executive control.

**Study Procedure:** After obtaining informed consent, all participants proceeded to complete the SAS-SV questionnaire. Cognitive performance was assessed using the TMT-A, TMT-B, and 2-Back Task under standardised conditions. The prevalence of smartphone addiction and cognitive decline was assessed, and the relationship between smartphone addiction and cognitive impairment was examined. Participants experiencing cognitive decline underwent a baseline cognitive assessment before engaging in an 8-week multicomponent exercise program supervised by a qualified physiotherapist. The intervention comprised sessions lasting 60 minutes, conducted four times a week. Each session included warm-up exercises, moderate-intensity aerobic training, strengthening exercises, balance and coordination training, dual-task cognitive activities, and cool-down exercises. Throughout the intervention, exercise intensity and task complexity were systematically elevated in accordance with individual tolerance and safety considerations.

Upon completion of the intervention, cognitive function was re-evaluated utilising the same standardised outcome measures, and a comparison of pre- and post-intervention scores was conducted to assess the effectiveness of the exercise program.

**Statistical Analysis:** Data were entered into Microsoft Excel and analysed using SPSS version 26.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequency and percentage. The incidence of smartphone addiction and cognitive decline was assessed through descriptive statistics. Associations between smartphone addiction and cognitive decline were analysed using the Pearson Chi-square test, and binary logistic regression was conducted to estimate odds ratios with 95% confidence intervals. Changes in cognitive outcomes following the intervention were analysed using the paired t-test or Wilcoxon signed-rank test, based on the normality of the data. A p-value of less than 0.05 was deemed statistically significant.

## RESULTS

A total of 346 Google Forms were distributed to young adults. Out of the total, 316 participants completed the survey and cognitive assessments. In accordance with the established criteria, 121 participants with cognitive decline were enrolled in the 8-week multicomponent exercise program. The results are outlined below.

**Table 1. Baseline Characteristics of Participants According to Smartphone Addiction Status (N = 316)**

| Variable | Smartphone Addiction (n = 118) | No Smartphone Addiction (n = 198) | Test Statistic | p-value |
|---|---|---|---|---|
| **Age (years)** | 22.84 ± 2.13 | 22.36 ± 2.21 | t = 1.89 | 0.060 |
| **BMI (kg/m²)** | 23.48 ± 3.12 | 22.91 ± 2.96 | t = 1.62 | 0.106 |
| **Daily Screen Time (hours/day)** | 6.52 ± 1.43 | 4.38 ± 1.36 | t = 13.21 | <0.001 |
| | | | $\chi^2 = 2.01$ | 0.156 |
| **Gender** | | | | |
| **Male** | 37 (43.5%) | 48 (56.5%) | | |
| **Female** | 81 (35.1%) | 150 (64.9%) | | |
| **Screen Time Categories** | | | $\chi^2 = 24.82$ | <0.001 |
| **<4 hours/day** | 18 (20.0%) | 72 (80.0%) | | |
| **4–6 hours/day** | 44 (36.7%) | 76 (63.3%) | | |
| **>6 hours/day** | 56 (52.8%) | 50 (47.2%) | | |

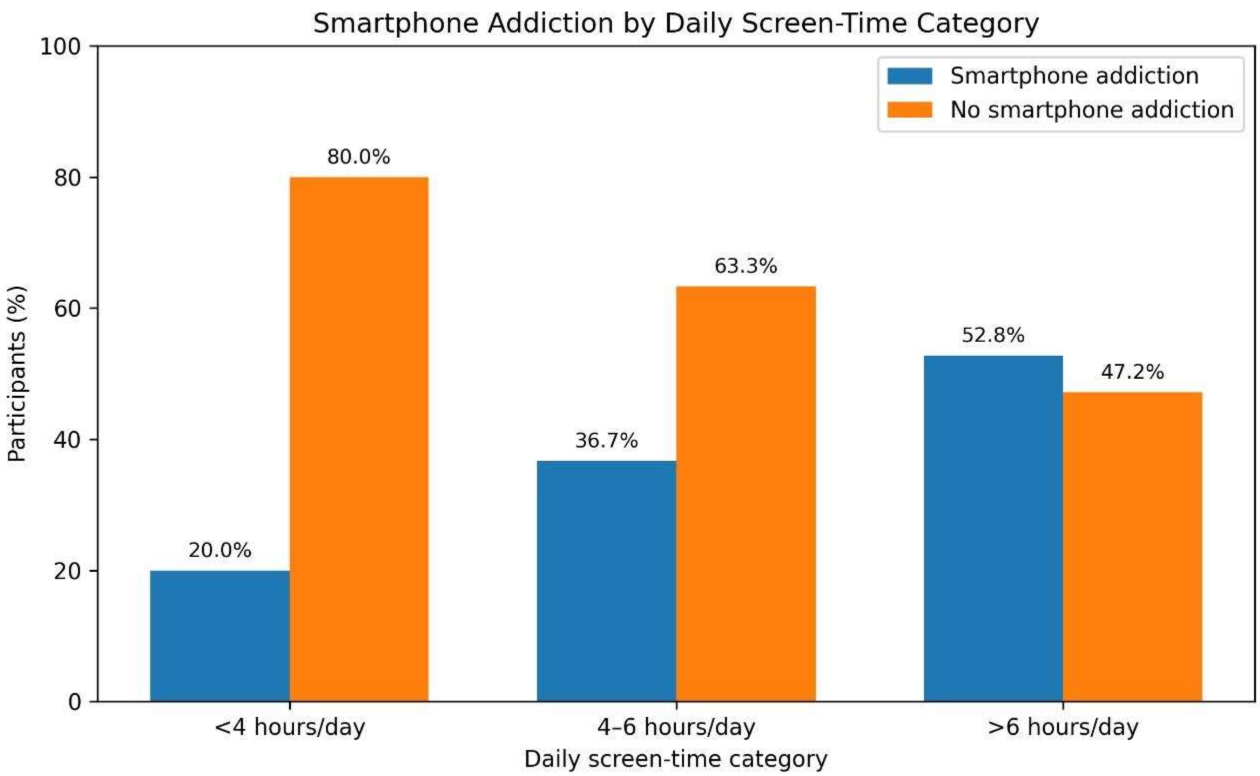


**Figure 1: Smartphone Addiction by Daily Screen-Time Category**

There were no statistically significant differences in age, BMI, or gender between the two groups ($p>0.05$). Participants with smartphone addiction had significantly greater daily screen time than non-addicted participants ($p<0.001$). Screen time categories were also significantly associated with smartphone addiction, with the highest prevalence observed among individuals reporting more than 6 hours of daily smartphone use.

**Table 2. Prevalence of Smartphone Addiction (SAS-SV) and Cognitive Decline (N = 316)**

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| **Smartphone Addiction (SAS-SV)** | | |
| **Addicted** | 118 | 37.3% |
| **Not Addicted** | 198 | 62.7% |
| **Cognitive Decline** | | |
| **Present** | 121 | 38.3% |
| **Absent** | 195 | 61.7% |

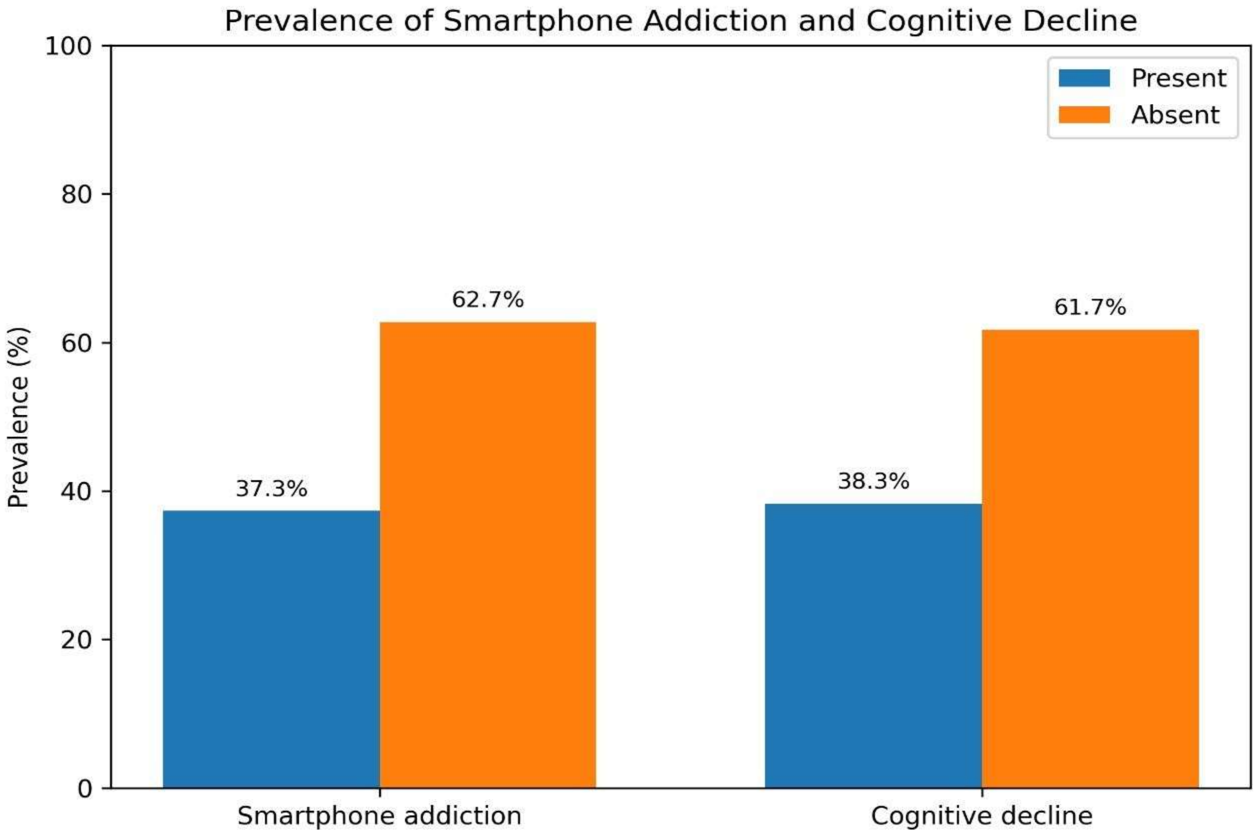


**Figure 2: Prevalence of Smartphone Addiction and Cognitive Decline**

Out of 316 young adults, 118 individuals, representing 37.3%, fulfilled the SAS-SV criteria for smartphone addiction. Cognitive decline was observed in 121 participants (38.3%), while 195 participants (61.7%) exhibited normal cognitive function.

**Table 3. Association Between Smartphone Addiction and Cognitive Decline**

| Smartphone Addiction Status | Cognitive Decline n (%) | No Cognitive Decline n (%) | Total |
|---|---|---|---|
| **Smartphone Addiction** | 85 (72.0%) | 33 (28.0%) | 118 |
| **No Smartphone Addiction** | 36 (18.2%) | 162 (81.8%) | 198 |
| **Total** | 121 | 195 | 316 |

Cognitive decline was significantly more common among participants with smartphone addiction (72.0%) compared to those without (18.2%), indicating a robust association between excessive smartphone use and diminished cognitive function.

**Table 4. Chi-square Analysis and Binary Logistic Regression for Cognitive Decline**

| Chi-square Analysis | Value | Binary Logistic Regression | Value |
|---|---|---|---|
| **Pearson χ²** | 92.35 | **Predictor** | Smartphone Addiction |
| **Degrees of Freedom (df)** | 1 | **Odds Ratio (OR)** | 11.59 |
| **p-value** | <0.001 | **95%Confidence Interval** | 6.75–19.90 |
| **Cramer's V** | 0.541 | **p-value** | <0.001 |

Pearson's chi-square test revealed a statistically significant association between smartphone addiction and cognitive decline ($\chi^2 = 92.35$, df = 1, $p < 0.001$). The Cramer's V value of 0.541 indicated a substantial effect size, suggesting a significant association between smartphone addiction and cognitive decline. Binary logistic regression analysis indicated that smartphone addiction serves as a significant predictor of cognitive decline. Participants identified as addicted exhibited 11.59 times greater odds of experiencing cognitive decline compared to their non-addicted counterparts (OR = 11.59; 95% CI: 6.75–19.90; $p < 0.001$).

**Table 5. Comparison of Cognitive Performance Between Smartphone-Addicted and Non-Addicted Participants**

| Outcome Measure | Smartphone Addiction Mean ± SD | No Smartphone Addiction Mean ± SD | t-value | p-value |
|---|---|---|---|---|
| **TMT-A (seconds)** | 41.82 ± 8.56 | 29.74 ± 5.91 | 14.63 | <0.001* |
| **TMT-B (seconds)** | 94.63 ±18.72 | 68.25 ±12.84 | 15.28 | <0.001* |
| **2-Back Accuracy (%)** | 71.84 ±9.63 | 90.42 ±5.78 | -21.11 | <0.001* |

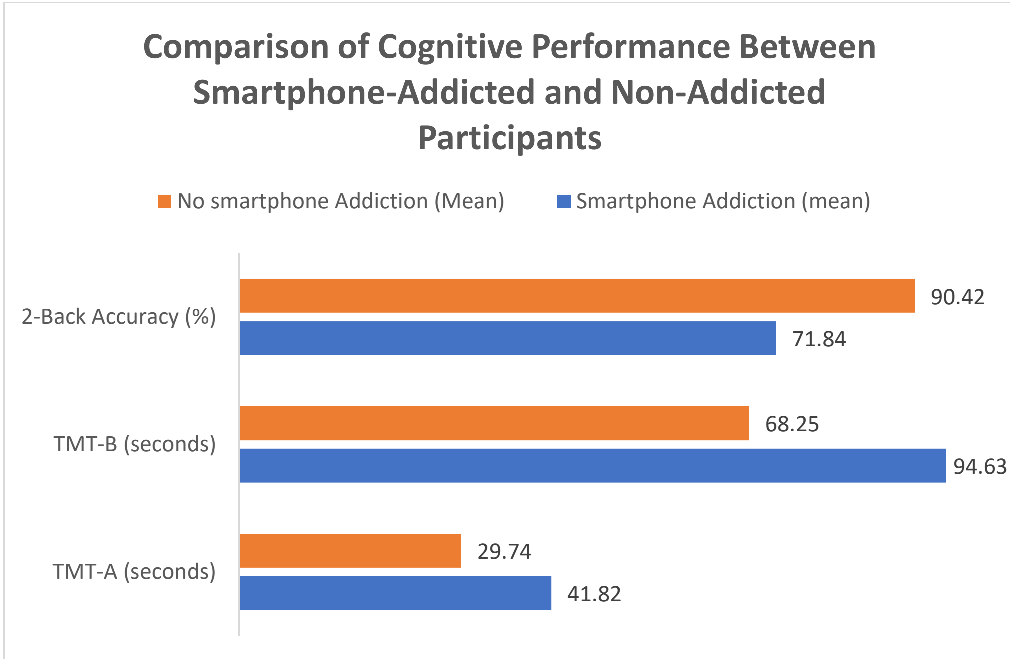


**Figure 4: Comparison of Cognitive Performance between Smartphone addicted and non-addicted participants**

Participants exhibiting smartphone addiction showed markedly inferior cognitive performance compared to those without such addiction. Participants exhibited markedly extended completion times on TMT-A and TMT-B, alongside significantly reduced 2-Back accuracy (all $p<0.001$). This suggests notable impairments in attention, executive functioning, cognitive flexibility, and working memory.

**Table 6. Effect of Multicomponent Exercise on Cognitive Function (Paired Pre- vs Post-Intervention) (n=121)**

| Outcome Measure | Pre-test Mean ± SD | Post-test Mean ± SD | Mean Difference | t-value | p-value | Cohen's $d_z$ |
|---|---|---|---|---|---|---|
| **TMT-A (seconds)** | 44.79 ±4.03 | 35.70 ±4.14 | 9.09 | 12.84 | <0.001* | 1.17 |
| **TMT-B (seconds)** | 101.73 ±9.93 | 84.83 ±10.41 | 16.90 | 15.91 | <0.001* | 1.45 |
| **2-Back Accuracy (%)** | 71.58 ±4.75 | 83.14 ±4.93 | 11.56 | 14.87 | <0.001* | 1.35 |

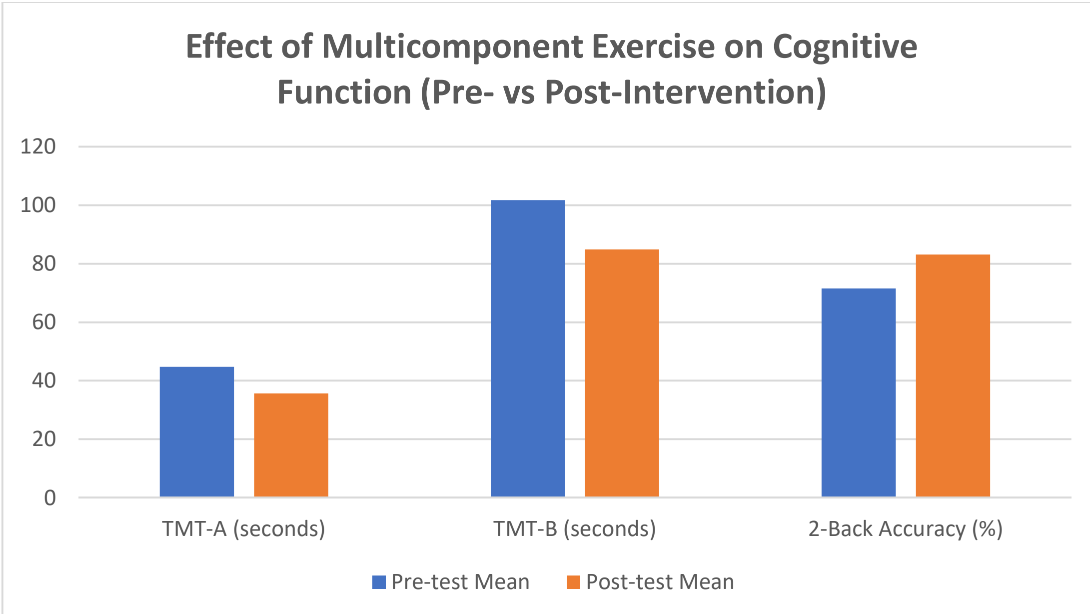


**Figure 5: Effect of Multicomponent Exercise on Cognitive Function (Pre vs Post Intervention)**

After the multicomponent exercise intervention, participants exhibited statistically significant enhancements in all cognitive outcomes ($p<0.001$). The completion times for TMT-A and TMT-B were notably decreased, indicating enhancements in attention, processing speed, executive function, and cognitive flexibility. Furthermore, there was a significant increase in 2-Back accuracy, suggesting an improvement in working memory. The findings demonstrated a significant effect size in TMT A, TMT B, and the 2Back task, suggesting clinically meaningful enhancements in cognitive performance following the intervention.

## DISCUSSION

The current study revealed that 37.3% of young adults experienced smartphone addiction, while 38.3% showed signs of cognitive decline, underscoring the increasing influence of excessive smartphone usage on cognitive health. Individuals exhibiting smartphone addiction demonstrated markedly higher daily smartphone usage and exhibited diminished performance in areas such as attention, processing speed, executive function, cognitive flexibility, and working memory compared to their non-addicted counterparts. These findings align with earlier research conducted by Sohn et al. and Davey and Davey, which highlighted a significant prevalence of problematic smartphone use among young adults and underscored its growing relevance to public health.[13,14]

A significant finding of this study was the robust correlation between smartphone addiction and cognitive decline. Participants with smartphone addiction exhibited 11.59 times greater odds of cognitive impairment, reinforcing the notion that excessive smartphone use negatively impacts higher cognitive functions. Similar findings have been reported by Wilmer et al., who demonstrated that frequent smartphone use impairs attention, executive function, and working memory through continuous multitasking, cognitive overload, and frequent attentional shifts.[3] Similarly, Ward et al. demonstrated that the mere presence of a smartphone can diminish cognitive capacity during challenging tasks, indicating that smartphones disrupt sustained attention and executive processing.15

After completing the 8-week multicomponent exercise program, participants showed notable enhancements across all cognitive outcome measures, including attention, executive function, cognitive flexibility, processing speed, and working memory. These findings align with the research conducted by Northey et al., which indicates that multicomponent exercise improves cognitive performance through mechanisms such as increased cerebral blood flow, enhanced neuroplasticity, and the stimulation of neurotrophic factors, including brain-derived neurotrophic factor (BDNF).16,17 The integration of aerobic, strengthening, balance, coordination, and dual-task cognitive exercises likely facilitated concurrent activation of motor and cognitive neural networks, leading to significant enhancements in cognitive performance.

Overall, the findings indicate that smartphone addiction represents a significant risk factor for cognitive decline in young adults, and that a multicomponent exercise approach serves as an effective, safe, and non-pharmacological physiotherapy intervention for enhancing cognitive function. Timely recognition of problematic smartphone usage and the introduction of organised exercise programs may contribute to the maintenance of cognitive health and mitigate the negative cognitive impacts linked to excessive smartphone use.

## CONCLUSION

The current study concludes that high levels of smartphone use correlate with cognitive decline in young adults and shows that an 8-week multicomponent exercise program serves as an effective physiotherapy intervention for enhancing attention, executive function, cognitive flexibility, and working memory. These findings endorse the integration of structured multicomponent exercise into cognitive rehabilitation, preventive care, and health promotion programs to maintain cognitive function and enhance long-term cognitive well-being in young adults experiencing problematic smartphone use.

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