Original Research Article

Association of Smartphone Use with Cognition, Handgrip Strength and Manual Dexterity in Community Dwelling Elderly: A Cross-Sectional Observational Study

Ravisha S. Sharma[1], Neha Rastogi[2]

[1]MPT Student- Government Physiotherapy College- New Civil Hospital Surat
[2]Senior Lecturer- Government Physiotherapy College- New Civil Hospital Surat

Corresponding Author: Dr. Ravisha S Sharma (PT)

ABSTRACT

BACKGROUND: Aging is associated with physiological and cognitive decline, leading to increased dependency among the growing elderly population. Smartphones and digital technologies offer opportunities to enhance communication, cognitive engagement, and quality of life in older adults. Hand grip strength and manual dexterity are important indicators of physical and cognitive health. Although smartphone use has been shown to benefit cognitive function, limited research has examined its impact on hand grip strength and manual dexterity in the elderly.

OBJECTIVE: To find association of smartphone use with Cognition, Hand grip strength and Hand dexterity in community dwelling elderly.

METHODOLOGY: After ethical clearance, this cross-sectional observational study had 120 participants with the age group 60 years and more. Selection was based on inclusion/exclusion criteria from Surat city. After consent from all the participants, outcomes were measured: Cognition by Montreal Cognitive Assessment (MoCa), Handgrip strength by JAMAR hand held Dynamometer and Manual dexterity by 9-hole peg test.

RESULTS: The IBM SPSS version 26.0 was used for analysis. The average MOCA Score for smartphone users (23.7±3.1) were more than non-users (19.9±4.0), as well as average hand grip strength of dominant hand was more in smartphone users (25.2±7.9) than the non-users (21.2±7.5). The Mann-Whitney test showed the significance of difference of average MoCa Score(p=0.000) and average hand grip strength of dominant hand (0.012) was significantly more in smartphone users.

CONCLUSION: This study highlights significant associations between smartphone use, cognitive function, and dominant hand grip strength in elderly individuals, with no observable impact on hand dexterity.

Keywords: Aging, Smartphone use, Cognitive function, Hand grip strength, Hand dexterity

INTRODUCTION

In India, senior citizens are defined as older adults of Indian nationality aged 60 years and above. The older adult population has increased from 24.7 million in the 1961 census to a projected 137.9 million and 158.7 million for the 2022 and 2025 censuses, respectively, accounting for

11.1% of the overall population.[1] In the 20th century the elderly population has represented the fastest growing segment of total world population.[2] According to the Report of the Technical Group on Population Projections for India and States 2011-2036, there are nearly 138 million elderly people in India in 2021 comprising of 67 million males and 71 million females.[3]

Aging is a normal and unavoidable process linked to the gradual decline of physiological abilities and functioning. Because it involves retirement, isolation, grieving over the loss of a loved one, and deteriorating health and wellness, it is also a time of change for many people.[4] Age-related physical functional impairments increase reliance on others. India's population is changing from having high fertility, high birth rates, and high death rates to having low fertility, low birth rates, and low death rates.[5] The demographics of population aging in India shows that the proportion of population aged 15-59 and 60 years and above are projected to increase while 0-14 years are projected to decline rapidly.[6]

Nevertheless, as the aging population grows, there is a noticeable shift among the elderly towards leading more digitally connected lives. The ownership of smartphones among seniors shows significant variation based on age. Approximately 59% of individuals aged 65-69 own smartphones, while the ownership decreases to 49% among those aged 70-74. However, there is a considerable decline in smartphone ownership in the mid-70s and beyond.[7]

A Smartphone, or smartphone, is a term for distinguishing mobile phones with advanced features from basic feature phones.[8] The advent of smartphones and other wireless mobile devices has increased the frequency of previously carried out digital activities on other devices such as laptops and desktop computer.[9] By providing conveniently accessible and reasonably priced communication devices that encourage contact in a variety of ways, such as text messaging, email, and audio or video communication at any time and from any location, technology helps older adults overcome the social and spatial barriers to social interaction. In today's world, a large number of older folks are connected through digital media, yet their networks are quite small. Some elderly folks are less adept at utilizing the benefits of technology to improve connections and are not proficient in using digital media to stay in touch with conventional family groups and neighbors.[10] Digital technology may be effective in improving elderly people's quality of life and facilitating their social participation and involvement into communities, although there are concerns, such as personal security and privacy.[11]

Cognition, a highly intricate function of the human brain, encompasses language, attention, orientation, memory, judgment, abstract reasoning, problem-solving, praxis, and executive function.[12] Cognition is critical for functional independence as people age, including whether someone can live independently, manage finances, take medications correctly, and drive safely. Cognitive abilities often decline with age.[13]

Cognitive abilities can be divided into several specific cognitive domains including attention, memory, executive cognitive function, language, and visuospatial abilities. Each of these domains has measurable declines with age. Speech and language function remains largely intact with advancing age. Vocabulary, verbal reasoning, and speech comprehension in normal conversation all remain stable into advanced age. There are age-related declines in aspects of visuospatial processing and constructional praxis. Visual recognition of objects, shapes, gestures, and conventional signs remains stable into advanced age. However, visual perceptual judgment and ability to perceive spatial orientation decline with age.[14] Identifying quantifiable indicators linked to cognitive impairment in older adults who are in good

health would aid in the early detection and potentially the prevention of pathological cognitive decline, including conditions like mild cognitive impairment (MCI). [15]

According to earlier research, using distinct cognitive domains is necessary for completing various technological activities. An Internet search, for instance, involves memory (remembering how to open a browser), attention (finding and concentrating on pertinent material), visuospatial skills, and executive functions (arranging necessary tasks in the right sequence). Additionally, language proficiency is linked to social networking and phone calls. [16] A study in the UK has revealed that use of mobile devices by older adults can support mental health, promote self-reliance, prevent loneliness, and improve mood. [17] However, such research is scant in India. Numerous epidemiological investigations, employing cross-sectional and longitudinal approaches, have consistently revealed a correlation between physical and cognitive functions in older adults. Broadly, older adults displaying diminished physical performance typically exhibit lower cognitive function. [18]

Handgrip strength (HGS) is a means of measuring muscle strength that has been used to evaluate important health outcomes in older people. [19] Although gait function impairment has received a lot of attention lately as a potential motor risk factor for cognitive function impairment, hand motor function impairment is also a potential candidate risk factor for cognitive impairment due to its correlation with cortical brain activity. The results showing that people with Alzheimer's disease (AD) performed worse on hand-motor activities than people with MCI, who in turn did worse than older persons without cognitive impairment, provide strong evidence for this. [15]

Evaluation of the musculoskeletal aspect of hand function typically involves the assessment of hand grip strength through the use of manual dynamometry. [20] The hand grip strength is measured easily by a hand-held dynamometer (HHD), one popular example being Jamar's hand-held hydraulic dynamometer. The hand-held dynamometer produces a measure of isometric strength that allows identifying not only muscle weakness of the upper limb but also providing an indicative of overall strength since it reflects the strength of the lower limbs. [21]

Furthermore, hand grip strength is recognized as a crucial health indicator, given its association with adverse geriatric conditions, including frailty, coronary heart disease, falls, disability, and mortality. [20] Several studies have shown significant associations of handgrip strength with single domains of intrinsic capacity, such as cognition, depression, and other health related outcomes, including frailty, mortality and vitality. [22]

Hand function assessments often include the evaluation of age-related impairments in the sensory system and the interaction between the sensory and motor systems. These impairments are reflected in decreased tactile sensibilities, reduced fine motor coordination, reduced manual speed, and increased response time. Intactness of the sensory-motor system is manifested in manual dexterity, defined as the ability to manipulate objects with the hands. [20] The capacity to precisely and quickly regulate finger movements in a coordinated and adaptable way, such as fine control when gripping and manipulating small items, is known as manual dexterity. Humans have highly specialized manual dexterity, which enables a wide range of goal- and object-oriented manual control. As people age, their manual dexterity declines, which can have a detrimental effect on their independence and everyday living activities. Age-related deficits in maximal grip force, sensory functioning, and object manipulation and grasping have been documented in studies [Box and Block test, NHPT]. [23]

According to cross-sectional research, global cognitive performance is linked to either handgrip strength or hand dexterity.

Additionally, clinical research has shown that older persons with moderate cognitive impairment (MCI) and those with cognitively normal cognitive abilities differ significantly in their motor impairment (loss of muscular control or movement). These results make sense since successful performance of daily tasks requiring cognitive engagement, such writing, cooking, gardening, creating crafts, and playing instruments, requires handgrip strength and coordination.[24] A host of studies also suggested that engagement in cognitive challenging activities, such as watching television, reading, listening to music, or using a computer is related to the maintenance and improvement of cognitive functions in the elderly. The smartphone, which is the most widely-used and portable device of the current digital age, serves as an all-in-one device, offering an increasing number of useful and interesting applications for its users involving traditional functions such as phone, messaging, multimedia player, and Internet browser, as well as novel applications (apps) such as social networking and health related apps, to name a few. [16]

However, literature review regarding effect of smartphone on cognition in older adults are available, but to the best of our knowledge very few literatures review is available on smartphone effect on hand grip strength and hand dexterity in older adults. Therefore, the aim of this study is to determine effects of smartphone use altogether on cognition, hand grip strength and hand dexterity in older adults. Hence Understanding the relationship between smartphone use and cognitive and physical health can guide the development of interventions and guidelines to promote healthy aging in the context of increasing technology adoption.

MATERIALS & METHODS

This cross-sectional observational study was carried out among community dwelling elderly both female and male between 60 to 85 years of age living in Surat city. The study was conducted over the period of 6 months. The sample size was calculated using Open Epi Version 3.01 software at 95% confidence level with the prevalence rate of 8.2% of total Indian population according to previous studies [25] and 120 Community Dwelling elderly were included in the study. The participants were elderly who are able to read and write at least one of the three languages among Hindi, English, Gujarati. Exclusion criteria included individual with cerebral disease, active epilepsy, dementia, severe sensory impairments, chronic medical condition that could affect hand function, severe pain affecting ADLs and uncorrected vision and hearing.

The outcome measures used in the study included Montreal Cognitive Assessment Tool (MoCa) for cognition, [12,26,27] JAMAR Hand Dynamometer for handgrip strength [20] and 9-hole Peg Board Test for hand dexterity. [28]

After Ethical Approval was obtained from Government Physiotherapy College, Surat's Human Research Ethics Committee, participants were identified using inclusion and exclusion criteria. Participants who gave consent were enrolled in the study. Participants were then asked whether they possess a smartphone and were categorized as "Users" or "Non-users". Following outcome measure were taken-Cognition was assessed using MoCa consisting of 12 subtasks that includes memory, attention, language, visuospatial orientation. Based on language of understanding and writing the participants were given MoCa test in that particular language. Hand Grip strength was assessed and measured using Jamar Handheld Dynamometer. Manual Dexterity was assessed and measured using 9-hole pegboard test

Statistical Analysis

A cross-sectional observational study was conducted among 120 patients of dwelling elderly. Data were entered in Microsoft excel sheet and analysed using SPSS software version 26. Qualitative data were

described as frequency and percentages. Quantitative data were described as Mean and SD and analysed by using t-test/ Mann Whitney test. p-value less than 0.05 considered as a statistically significant.

RESULT

This cross-sectional study aimed to explore the association of smartphone use with cognitive function, hand grip strength, and hand dexterity among elderly individuals.

The data presented in Graph 1 shows that out of 120 participants, 77 (64.2%) are smartphone users, while 43 (35.8%) are non-users.
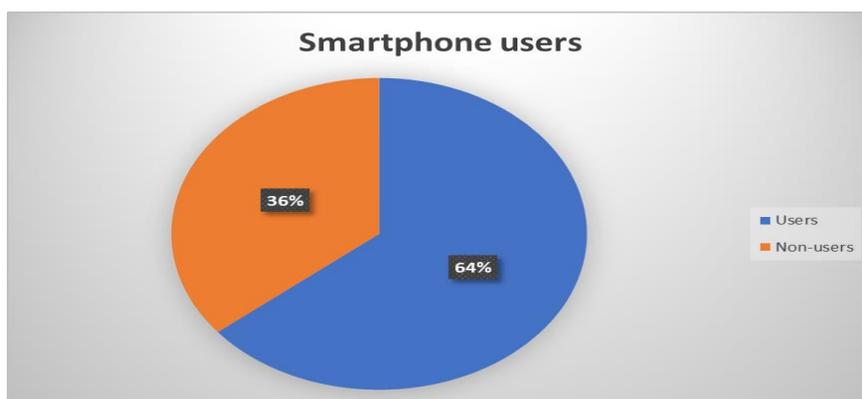
GRAPH 1: DISTRIBUTION OF SMARTPHONE USERS AND NON-USERS

TABLE 1: DESCRIPTIVE STATISTICS FOR MOCA SCORE/ HAND GRIP STRENGTH DOMINANT/ HAND GRIP STRENGTH NONDOMINANT/ DEXTERITY DOMINANT/ DEXTERITY NONDOMINANT

	USERS (77)				NON-USERS (43)			
	MIN	MAX	MEAN	SD	MIN	MAX	MEAN	SD
MOCA SCORE	15.00	29.00	23.714	3.170	11.00	29.00	19.907	4.070
HAND GRIP STRENGTH DOMINANT	10.00	45.00	25.247	7.935	3.00	37.00	21.200	7.568
HAND GRIP STRENGTH NONDOMINANT	9.00	45.00	23.757	7.994	8.00	37.50	21.360	6.848
DEXTERITY DOMINANT	20.00	44.00	26.805	5.388	18.00	41.00	27.953	5.802
DEXTERITY NONDOMINANT	20.00	41.00	27.974	5.407	18.00	49.00	29.256	5.965

From table-1 it can be observed that average MOCA Score is 23.714±3.1 for smartphone users, and 19.907±4.7 for non-users, average hand grip strength dominant 25.247±7.9 for smartphone users and 21.2±7.5 for non-users, average hand grip strength non-dominant 23.757±7.9 for smartphone users and 21.36±6.8 for non-users, average dexterity dominant 26.805±5.3 for smartphone users and 27.953±5.8 for non-users, average dexterity non-dominant 27.974±5.4 for smartphone users and 29.256±5.9 for non-users.

TABLE 2: TEST OF NORMALITY

	TEST OF NORMALITY: SHAPIRO-WILK		
	STATISTIC	DF	SIG.
MOCA SCORE	.960	120	.001
HAND GRIP STRENGTH DOMINANT	.959	120	.001
HAND GRIP STRENGTH NONDOMINANT	.952	120	.000
DEXTERITY DOMINANT	.926	120	.000
DEXTERITY NONDOMINANT	.947	120	.000

The above table 2 showed Shapiro Wilk Test was applied to test the Normality of data. The result of the normality test indicates the data for all variables- MoCa

Score, Handgrip strength of dominant hand, Handgrip strength of non-dominant hand, Dexterity of Dominant hand, Dexterity of non-dominant hand are not normally distributed as evidenced by Shapiro-Wilk test statistics and significant p-values ($p < 0.05$ for all variables)

TABLE 3: STATISTICS TEST FOR SIGNIFICANC

	MANN-WHITNEY TEST	P-VALUE
MOCA SCORE	747.00	0.000
HAND GRIP STRENGTH DOMINANT	1199.50	0.012
HAND GRIP STRENGTH NONDOMINANT	1374.00	0.122
DEXTERITY DOMINANT	1873.00	0.233
DEXTERITY NONDOMINANT	1900.00	0.180

From table-3 it can said that average MoCa Score and hand grip strength dominant are significantly different. Rest of the variables are insignificant.

Hence, it can say that average MoCa Score is significantly more in smartphone users, and average hand grip strength dominant is significantly more in smartphone users. Average of remaining variables are insignificant.

DISCUSSION

This cross-sectional study aimed to explore the association of smartphone use with cognitive function, hand grip strength, and hand dexterity among elderly individuals. The findings provide insights into the potential cognitive and physical implications of smartphone use in aging populations. The study rejected two of the three null hypotheses and showed the association between smartphone use with cognition and hand grip strength. The cognition and hand grip strength of dominant side both were higher in smartphone user as compared to non-user. However, hand dexterity did not differ between the smartphone users and non-users.

The data presented in Graph 1 shows that out of 120 participants, 77 (64.2%) are smartphone users, while 43 (35.8%) are non-users. This distribution offers valuable insight into the prevalence of smartphone usage within the sample group. This is in the accordance with survey carried out in India by J. Antony William and Murgesh R that showed the participants aged more than 60 years expressed that they are not scared and hesitant to use technology. They are also aware of the value of new technologies and show their willingness to adopt, if it improves their quality of life with security. [6]

Effect of smartphone use on cognition was assessed by comparing Montreal Cognitive Assessment Score of smartphone users and non-users. According to this study we can observe that average MOCA Score was (23.7±3.1) for smartphone users, and (19.9±4.0) for non-users as shown in table-1. The similar findings were observed in national cross-sectional survey of China conducted by Qi S, Sun Y, Yin P et al. where the prevalence of cognitive impairment in non-users of mobile phone, dumbphone users, and smartphone users were 17.8%, 5.0%, and 1.4%, respectively.[11] Another survey conducted by Lin L, Jing XC, Lv SJ et al. among older adults living in residential homes found users of mobile devices had a significantly higher total MoCA score (25.02 ± 4.14) and a significantly lower GDS-15(geriatric depression scale) score (3.28 ± 2.74) than non-users (MoCA: 19.34 ± 5.21, GDS-15: 4.69 ± 2.90).[17] The higher cognitive scores among smartphone users suggest that regular smartphone use might be associated with better cognitive engagement. Smartphones provide access to activities that challenge memory, attention, and executive function, such as browsing, gaming, and using apps, potentially contributing to improved cognitive health.

Other research also points out that Internet use augments cognitive skills, stating that some areas of the brain in the normal subjects aged 55-76 were more active in both decision-making tasks and complex reasoning tasks after several sessions of Internet search. In addition, playing games on mobile devices has also been proven to have generalized positive effects on cognitive control abilities in older adults.[17] Similar findings were also observed by Vaportzis E, Martin M et al. concluding Engagement in a new mentally challenging activity (tablet training) was associated with improved processing speed .Acquiring skills in later life, including those related to adopting new technologies, may therefore have the potential to reduce or delay cognitive changes associated with ageing.[29] Besides Social interaction is considered as one of the lifestyle factors that play a significant role in maintaining or improving cognitive functioning in older adults. A growing body of literature has described positive effects of social engagement and negative effects of social isolation on cognitive performance in older adults. [17] In the present cross-sectional study, we may consider that Smartphones enable elderly users to maintain relationships with family and friends via messaging apps, video calls, and social networks, that in turn enhanced communication mitigates feelings of isolation, which is linked to cognitive decline. Using a smartphone engages the brain in novel ways, potentially strengthening neural connections and building cognitive reserve.

According to the procedure MoCa Scale scoring was done by adding one point for subject who had 12 years or fewer of formal education, for a possible maximum of 30 points. The data on educational qualification was collected and according to analysis revealed a clear correlation between educational attainment and smartphone usage. In graduates 91% were smartphone users, suggesting a strong link between higher education and technology adoption. While in HSC participants: 87% were smartphone users, showing a similar trend. In SSC participants only 42% were smartphone users, with the majority (58%) being non-users. Higher education levels may equip individuals with better digital literacy skills and more frequent exposure to technology. Additionally, socioeconomic factors often associated with higher education, such as better financial resources, may facilitate smartphone ownership. Studies show that individuals with higher education experience a slower rate of cognitive decline with age. Chen Y, Lv C, Li X et al concluded that the highly educated elderly have a higher level of wide cognitive function, higher frequencies of knowledge-related leisure activities, and smaller age-related anterior and temporal regional GM/WM integrity declines during aging. [30]

To determine the association between smartphone, use and handgrip strength the average grip strength was assessed using hand held Dynamometer. Average hand grip strength for dominant hand is 25.247 for smartphone users and 21.2 for non-users, average hand grip strength non-dominant 23.757 for smartphone users and 21.36 for non-users as shown in table-1. Analysis showed average hand grip strength dominant is significantly more in smartphone users. However, in younger generation while assessing the effective interaction of smartphone use along with hand dominance on children's grip strength and functional hand performance, Bhamra JK, Naqvi WM et al found the high levels of smartphone use were found to harm hand grip strength as well as hand function. That is, the grip strength of high-frequency smartphone users' dominant hands was diminished.[31] Another study by Ahmad Osailan determined that prolonged use of smartphones was related to weaker hand-grip and pinch-grip.[32] However, in young adults hand grip strength reduction was associated with smartphone addiction, and in elderly findings by Busch PA, Hausvik GI, Ropstad OK et al. suggest a low prevalence of problematic usage of phone

(2,4%), indicating that the use of smartphones is less problematic among older adults.[9] Different results in elderly may be attributed to the explanation that Smartphone usage involves frequent hand and finger movements, such as typing, swiping, pinching, and tapping along with wrist flexion-extension. These activities require fine motor skills and continuous engagement of hand muscles, which may contribute to improved hand strength over time. Elderly individuals who do not use smartphones may miss out on these repetitive, low-intensity exercises. Their hand muscles might not receive the same level of regular stimulation, leading to relatively lower grip strength.

Beside Kobayashi-Cuya KE, Sakurai R, Suzuki H et al. through a systemic review determined that Handgrip strength associates with cognitive performance cross sectionally and longitudinally; however, it is unclear to speculate which variable that is having weak handgrip strength or having low cognitive performance at baseline, affects the other in the long-term.[15] Therefore we may conclude the increase in handgrip strength observed in elderly smartphone users may not only be directly attributable to the physical component of muscle function but also to the cognitive engagement involved in using smartphones, which can enhance neural pathways related to motor control and coordination.

Another finding observed in present study was the presence of significant increase in handgrip strength in dominant hand as compared to non-dominant in smartphone users. This study highlighted the distribution of dominant hand preference among a sample of 120 individuals. The findings reveal that: 95% of participants are right-hand dominant, with a frequency of 114 individuals. 5% of participants are left-hand dominant, with a frequency of 6 individuals. There was significant increase in hand grip strength only in dominant side among smartphone user. However, in young adults, study by Gandhi T and Annamalai N. it was observed that excessive usage of smartphones can have a detrimental effect on hand strength, both on the dominant and non-dominant side of the user's hands. [33] The different findings in elderly can be attributed to most people hold smartphones with their non-dominant hand and use the dominant hand for navigation and typing. This habit ensures that the dominant hand is more actively involved in performing tasks that require strength and fine motor skills, reinforcing its musculature over time which is needed to be explored more by including other references.

The null hypothesis of association of smartphone use with manual dexterity was accepted and no significant association was found between the two components. According to table 1 average dexterity in dominant hand was 26.805 for smartphone users and 27.953 for non-users, average dexterity non-dominant 27.974 for smartphone users and 29.256 for non-users, which on statistical analysis determined no significant increase and difference of hand dexterity between smart users and non-users. The findings are in accordance to a study by Elboim-Gabyzon M and Danial-Saad A. which indicated that touchscreen manipulation ability among healthy elderly individuals 65 years of age or older was not correlated with grip and pinch strength and manual dexterity as touchscreen performance appears to be related to specific constructs of hand function unlike simple hand grip and dexterity.[20] Beside according to Kobayashi-Cuya KE, Sakurai R, Sakuma N et al. hand dexterity is vulnerable to the effects of aging and, contrary to handgrip strength, it strongly associates with executive function, independent of global cognition. [24] Therefore, indirect effects of improvement in cognition were not seen in smart phone users. Similar findings were observed by Petrigna L, Treigienė M, Thomas E et al. in young adults concluding that the time spent on the smartphone by young adults does not influence the time to complete the Grooved Pegboard test, indicating that smartphone use does not influence measures of manual

dexterity.[34] According to Elboim-Gabyzon M and Danial-Saad A. using smart-phone consist of performing more complex gestures that require greater accuracy (dragging task) or rapid movements (double tapping) and are related to hand strength and manual dexterity. The results suggested that the manual gestures necessary for touchscreen operation entail unique and specific capabilities that are generally not captured by traditional tools. The clinical implication was that the hand function assessment toolbox should be expanded. [20] Following finding can be attributed to the reason that traditional tools for assessing hand strength and dexterity often focus on basic metrics like grip or pinch strength and simple motor tasks. These may not fully reflect the nuances of hand function required in modern-day activities, particularly touchscreen interactions.

The sample consisted of 120 participants, with females making up 53.3% and males 46.7%. This nearly balanced gender representation ensures that the results are not skewed toward one gender, allowing for generalizable conclusions about smartphone use and associated traits. As it was mentioned by Yuan M, Chen J, Zhou Z et al. in their study determining joint association of smartphone use and gender on cognition that non-smartphone users' women significantly outperformed man in memory domain. And with regard to executive function, attention, language and orientation women had inferior position as compared to men. [16] Though such discrepancies were eliminated in this study, the study do not include analysis differentiating outcome measures in relation to gender.

The above all findings suggest that smartphone usage may promote cognitive reserve and motor engagement, particularly in the dominant hand, through activities requiring coordination, strength, and mental stimulation. Additionally, factors such as education and social interaction were shown to play a crucial role in technology adoption and its associated benefits, reinforcing the need for promoting digital literacy among older adults to improve quality of life.

CONCLUSION

This cross-sectional study reveals significant associations between smartphone use, cognitive function, and handgrip strength in elderly individuals, with no observable impact on hand dexterity. Smartphone users demonstrated higher cognitive performance (mean MoCA score (23.7±3.1 vs. 19.9±4.0) compared to non-users, suggesting that smartphone-related activities like gaming, browsing, and social interaction may enhance cognitive engagement by challenging memory, attention, and executive function while fostering neural connectivity and mitigating social isolation. Dominant hand grip strength was also higher among smartphone users (mean (25.2±7.9 vs 21.2±7.5), likely attributed to the repetitive, fine motor movements involved in smartphone usage. This improvement may stem not only from physical activity but also from cognitive engagement enhancing motor control and coordination. Non-dominant hand grip strength showed no comparable improvement, possibly due to less active involvement of the non-dominant hand in smartphone tasks. Despite higher cognitive scores and handgrip strength, there was no significant difference in hand dexterity between users and non-users, as traditional tools like the Nine-Hole Peg Test may not capture the specific capabilities required for touchscreen operation. Smartphone usage was more prevalent among participants with higher education levels, indicating a link between digital literacy, socioeconomic resources, and technology adoption. These findings suggest that smartphones can serve as a low-cost, accessible tool to promote cognitive and physical health in aging populations. However, further research, particularly longitudinal studies, is needed to establish causality and explore the nuanced relationship between smartphone use, manual dexterity, and the neural mechanisms underlying these changes.

Addressing barriers to smartphone adoption, such as digital literacy training, could amplify these benefits and enhance quality of life for the elderly.

Limitation
The cross-sectional design of the study limits causal interpretation of the findings. Although the sample size was adequate for preliminary analysis, generalizability is restricted due to cultural and socioeconomic factors. Smartphone usage was self-reported, which may have introduced recall bias. Conventional tools used to assess manual dexterity may not fully reflect touchscreen-specific hand functions. The predominance of participants with higher educational status and the exclusive inclusion of elderly individuals may have influenced the results. Additionally, several potential confounders, such as pre-existing medical conditions and other cognitive or hand-use activities, were not controlled.

Declaration by Authors
Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES
1. Vaishnav LM, Joshi SH, Joshi AU, Mehendale AM. The National Programme for Health Care of the Elderly: a review of its achievements and challenges in India. Annals of geriatric medicine and research. 2022 Sep;26(3):183.
2. Multani NK, Verma SK. Principles of geriatric physiotherapy. Jaypee Brothers Publishers;2008.
3. NSO. Elderly in India. National Statistical Office, Ministry of Statistics & Programme Implementation, Government of India, New Delhi; 2021. Available from https://mospi.gov.in/sites/default/files/public ation_reports/Elderly%20in%20India%20 2021.pdf.
4. Thampi K, Mathew LM. Aging in Place for Community-Dwelling Older Adults in India: A Qualitative Exploration of Prospects and Challenges. Gerontology and Geriatric Medicine. 2024 Jan; 10:23337214231223636.
5. Malik C, Khanna S, Jain Y, Jain R. Geriatric population in India: Demography, vulnerabilities, and healthcare challenges. Journal of Family Medicine and Primary Care. 2021 Jan;10(1):72
6. William JA, Murugesh R. Senior citizens usage towards and perception of modern technology in India. InHuman Aspects of IT for the Aged Population. Acceptance, Communication and Participation: 4th International Conference, ITAP 2018, Held as Part of HCI International 2018, Las Vegas, NV, USA, July 15–20, 2018, Proceedings, Part I 4 2018 (pp. 179-193). Springer International Publishing.
7. Grewal S, Sahni RK. Effect of smartphone addiction on reaction time in geriatric population. Journal of Novel Physiotherapy and Physical Rehabilitation. 2019 May 16;6(1):005-9.
8. Davey S, Davey A. Assessment of smartphone addiction in Indian adolescents: A mixed method study by systematic-review and meta-analysis approach. International journal of preventive medicine. 2014 Dec;5(12):1500.
9. Busch PA, Hausvik GI, Ropstad OK, Pettersen D. Smartphone usage among older adults. Computers in Human Behavior. 2021 Aug 1; 121:106783.
10. Sen K, Prybutok G, Prybutok V. The use of digital technology for social wellbeing reduces social isolation in older adults: A systematic review. SSM-population health. 2022 Mar 1; 17:101020.
11. Qi S, Sun Y, Yin P, Zhang H, Wang Z. Mobile phone use and cognitive impairment among elderly Chinese: a national cross-sectional survey study. International journal of environmental research and public health. 2021 May 26;18(11):5695.
12. Daniel B, Agenagnew L, Workicho A, Abera M. Psychometric properties of the Montreal cognitive assessment (MoCA) to detect major neurocognitive disorder among older people in Ethiopia: a validation study. Neuropsychiatric Disease and Treatment. 2022 Jan 1:1789-98.
13. Chang YH, Wu IC, Hsiung CA. Reading activity prevents long-term decline in cognitive function in older people: Evidence from a 14-year longitudinal study.

International Psychogeriatrics. 2021 Jan;33(1):63-74.

14. Murman DL. The impact of age on cognition. InSeminars in hearing 2015 Aug (Vol. 36, No. 03, pp. 111-121). Thieme Medical Publishers.

15. Kobayashi-Cuya KE, Sakurai R, Suzuki H, Ogawa S, Takebayashi T, Fujiwara Y. Observational evidence of the association between handgrip strength, hand dexterity, and cognitive performance in community-dwelling older adults: a systematic review. Journal of epidemiology. 2018 Sep 5;28(9):373-81.

16. Yuan M, Chen J, Zhou Z, Yin J, Wu J, Luo M, Wang L, Fang Y. Joint associations of smartphone use and gender on multidimensional cognitive health among community-dwelling older adults: A cross-sectional study. BMC geriatrics. 2019 Dec;19(1):1-0.

17. Lin L, Jing XC, Lv SJ, Liang JH, Tian L, Li HL, Puts M, Xu Y. Mobile device use and the cognitive function and depressive symptoms of older adults living in residential care homes. BMC geriatrics. 2020 Dec; 20:1-8.

18. Abe T, Soma Y, Kitano N, Jindo T, Sato A, Tsunoda K, Tsuji T, Okura T. Change in hand dexterity and habitual gait speed reflects cognitive decline over time in healthy older adults: a longitudinal study. Journal of physical therapy science. 2017;29(10):1737-41.

19. de Araújo Amaral C, Amaral TL, Monteiro GT, de Vasconcellos MT, Portela MC. Factors associated with low handgrip strength in older people: data of the Study of Chronic Diseases (Edoc-I). BMC Public Health. 2020 Dec; 20:1-0.

20. Elboim-Gabyzon M, Danial-Saad A. Correlation between the ability to manipulate a touchscreen device and hand strength and manual dexterity among community-living older individuals. International Journal of Environmental Research and Public Health. 2021 Sep 6;18(17):9408.

21. Vaishya R, Misra A, Vaish A, Ursino N, D'Ambrosi R. Hand grip strength as a proposed new vital sign of health: a narrative review of evidences. Journal of Health, Population and Nutrition. 2024 Jan 9;43(1):7.

22. Xuekelati S, Maimaitiwusiman Z, Xiang H, Wumaer A, Bai X, Wang H. Handgrip strength: A simple and effective tool to recognize decreased intrinsic capacity in Chinese older adults. Experimental Gerontology. 2024 Oct 15; 196:112567.

23. Carment L, Abdellatif A, Lafuente-Lafuente C, Pariel S, Maier MA, Belmin J, Lindberg PG. Manual dexterity and aging: a pilot study disentangling sensorimotor from cognitive decline. Frontiers in neurology. 2018 Oct 29; 9:910.

24. Kobayashi-Cuya KE, Sakurai R, Sakuma N, Suzuki H, Yasunaga M, Ogawa S, Takebayashi T, Fujiwara Y. Hand dexterity, not handgrip strength, is associated with executive function in Japanese community-dwelling older adults: a cross-sectional study. BMC geriatrics. 2018 Dec;18(1):1-8.

25. Sahoo SS, Kaur V, Panda UK, Nath B, Parija PP, Sahu DP. Depression and quality of life among elderly: Comparative cross-sectional study between elderly in community and old age homes in Eastern India. Journal of Education and Health Promotion. 2022;11.

26. Gupta M, Gupta V, Buckshee RN, Sharma V. Validity and reliability of Hindi translated version of Montreal cognitive assessment in older adults. Asian Journal of Psychiatry. 2019 Oct 1; 45:125-8.

27. Agnani PD, Bhise AR. Translation, cultural adaptation and validation of Gujarati version of Montreal Cognitive Assessment (MoCA) in older adults. Int J Sci Res. 2023;12(2): doi:10.36106/ijsr.

28. Hamilton LD, Thomas E, Almuklass AM, Enoka RM. A framework for identifying the adaptations responsible for differences in pegboard times between middle-aged and older adults. Experimental gerontology. 2017 Oct 15; 97:9-16.

29. Vaportzis E, Martin M, Gow AJ. A tablet for healthy ageing: the effect of a tablet computer training intervention on cognitive abilities in older adults. The American Journal of Geriatric Psychiatry. 2017 Aug 1;25(8):841-51

30. Chen Y, Lv C, Li X, Zhang J, Chen K, Liu Z, Li H, Fan J, Qin T, Luo L, Zhang Z. The positive impacts of early-life education on cognition, leisure activity, and brain structure in healthy aging. Aging (Albany NY). 2019 Jul 7;11(14):4923.

31. Bhamra JK, Naqvi WM, Arora SP. Effect of smartphone on hand performance and strength in the healthy population. Cureus. 2021 Jun 21;13(6).
32. Osailan A. The relationship between smartphone usage duration (using smartphone's ability to monitor screen time) with hand-grip and pinch-grip strength among young people: an observational study. BMC musculoskeletal disorders. 2021 Dec; 22:1-8.
33. Gandhi T, Annamalai N. Effect of smartphone usage on hand grip strength among healthy young adults. Int J Pharm Clin Res. 2023;15(2):982-7.
34. Petrigna L, Treigienė M, Thomas E, Mani D, Pajaujiene S, Drid P, Lavanco G, Palma A, Bianco A. Time spent on the smartphone does not relate to manual dexterity in young adults. BMC neuroscience. 2021 May 11;22(1):34.

******