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Aerobic training versus mobile application based cognitive training: impact on cognition, aerobic capacity, and quality of life of older adults – An experimental study

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Objective. India is undergoing population ageing, with 7.7% of its population being more than 60 years old. Ageing brings age related degenerative changes which can bring cognitive impairments. Aerobic exercise is an effective intervention. Cognitive rehabilitation through mobile phone application is relatively unexplored. This study is carried out to compare the effect of aerobic exercise and mobile application training on cognition, aerobic capacity and quality of life of older adults.
Methods. 32 participants, 60-75 years of age, eligible to perform aerobic activities and having smart phone were enrolled. Those who had associated neurological conditions, or problem with vision and hearing, were excluded. ACE-III, NCPT, 6MWT and QoL-AD were analysed and those with Mild Cognitive Impairments were randomly allocated to two groups. Group one was given moderate intensity aerobic training for 30 minutes, five days/week, for eight weeks. Group two was given cognitive training through mobile application Lumosity. Participants were asked to achieve daily targets and were made to play it for eight weeks. Follow up of all the outcome measures was taken after eight weeks.
Results. All four outcomes show significant improvement for within group analysis ($p < 0.05$). In between group analysis, no significant difference between the groups for cognition ($p=0.42$) and quality of life ($p = 0.92$). Aerobic capacity showed significant difference in between group analysis ($p < 0.01$).
Conclusions. Both aerobic capacity and mobile app training are equally effective for improving cognition and quality of life in older adults with MCI. Aerobic training group showed more improvement compared mobile training application group.

Key words: older adults, quality of life, cognition, aerobic capacity, cognitive rehabilitation, technology

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INTRODUCTION

India is the second largest populated country in the world with the population of 1.42 billion. Ageing of population is a global demographic trend. India too is experiencing "population ageing" [1]. Age related changes may come in form of degeneration of musculoskeletal system, neurological system, cardiopulmonary system, vision and hearing, etc. and the cumulative effect of these age-related changes causes a distinct impact on an individual's life [2].

Nervous system plays the utmost important role throughout the life span [3]. Cognition is the act or process of knowing, including awareness, reasoning, judgement, intuition, and memory. It serves as a foundation of one's behaviour and it is a goal directed processing activity. Executive functions like capacity to plan, manipulate information, initiate, and terminate activities, recognize errors, problem solving, and abstract thinking are also included as cognitive functions [4].

Age related degenerative changes to nervous system might cause cognitive decline which decreases their efficiency of conducting their ADL [5]. Mograbi and colleagues explains that executive functions play an important role in performing everyday tasks of instrumental ADLs. Due to same reason, decline in cognitive functions may cause decline in QoL of older adults [6].

Mild Cognitive Impairment (MCI) or dementia starts with symptoms of forgetfulness, lack of attention, drifting away from the task on hand, decreased speed of the decision making, visuospatial skill, perceptual speed and executive functioning [7].

Mini mental status examination, Montreal Cognitive Assessment, Rivermead Behavioural Memory test, Cognitive Assessment of Minnesota, Addenbrook's Cognitive Examination, etc. are few frequently used tools for the assessment and screening. Addenbrook's cognitive examination III (ACE III) is one such standardised tool to detect and monitor cognitive changes in dementia and mild cognitive impairment [8-10]. NCPT is a web based cognitive examination which measures several domains of cognition [11].

In today's era, with most people living beyond 60 years, continuous support and proper healthcare can enable them to live independently and positively impact society [12]. Designing and implementing rehabilitation programs for those at risk of or experiencing cognitive decline is crucial, as current programs face irregular compliance due to cost, inadequate instruction, and a shift toward non-conventional treatments. Studies globally highlight the effectiveness of physical activity in promoting healthy aging and improving cognitive functions, especially executive functions, though there is a lack of coherent studies from India. Additionally, while video games may not suit older adults in India, mobile phones being widely accessible and convenient offer an effective and compliant medium for cognitive training through interactive applications [13-15].

Hence, this study was planned with the aim of comparing the effect of aerobic training and mobile application based cognitive training on cognition, NCPT, aerobic capacity and quality of life in older adults.

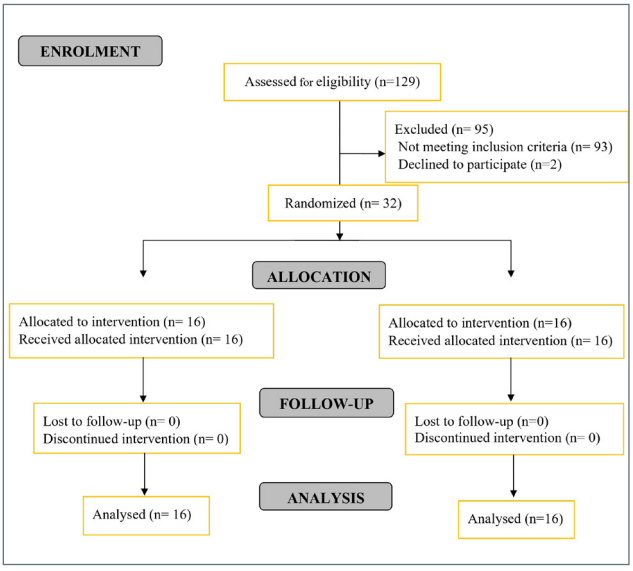

Figure 1. CONSORT flow diagram.

METHODS

In this experimental study, 32 older adults aged 60 to 75 years from old age homes, clubs operating for older adults and community dwelling older adults participated. Informed written consent was obtained from all the participants. After assessment, subjects were divided randomly using www.randomization.com Flow chart is shown in Figure 1.

Sample size: $N = 2^{(\sigma|\Delta)_2[Z_\alpha+Z_{1-\beta}]^2}$

*N = sample size per group, σ = Standard Deviation, Δ = critical difference, $Z\alpha$ = level of significance, $Z_{1-\beta}$ = power.

Sample size came to 12. Considering the dropout scenario, the sample size for the current study was kept as 16 per group.

Inclusion criteria

Participants included in the study were males and females aged between 60 to 75 years who owned and were comfortable using smartphones. All participants exhibited mild cognitive impairment, diagnosed using the Addenbrooke's Cognitive Examination – III (ACE-III), with scores ranging between 82 and 88. Additionally, only those individuals who were deemed eligible for aerobic training based on the Physical Activity Readiness Questionnaire were enrolled in the study.

Exclusion criteria

Participants were excluded if they had any neurological condition causing cognitive impairment, impaired upper limb dexterity, or uncorrectable visual or hearing

impairments that would interfere with communication or participation in the intervention.

Outcome measures

The primary outcome measures used in the study were the Addenbrooke's Cognitive Examination – III (ACE-III) for assessing cognitive function, the Six Minute Walk Test (6MWT) to evaluate aerobic capacity, the Quality of Life in Alzheimer's Disease (QoL-AD) scale to measure overall quality of life, and the Neuro Cognitive Performance Test (NCPT) to assess various domains of neurocognitive performance.

Procedure

Group 1. Aerobic training

Individuals were taught 30 minutes of exercise which included warm up and cool down. Tailor made protocol was used for all the individuals, which generally included exercises like, spot marching, brisk walking, star exercise, mini squatting, spot jogging, jumping jacks, stair climbing, static cycling, chair aerobic workout, etc. Exercises were of moderate intensity, five days a week for eight weeks as per ACSM guidelines for older adults [16].

Group 2. Mobile application based cognitive training Lumosity©

Permission to use Lumosity and NCPT was obtained. The application offered interactive games targeting various cognitive skills, such as planning, memory, attention, reasoning, and numerical estimation, with examples like Speed Pack, Lost in Migration, Ebb and Flow, Train of Thought, Tidal Treasure, Memory Matrix, Trouble Brewing, Star Search, Disillusion, Masterpiece, Fuse Clues, Pet Detective, Rain Drops, Chalkboard Challenge, Spatial Speed Match and Colour Match. It set daily reminders and targets, tracked gameplay frequency and variety, and monitored compliance. Weekly therapist follow-ups were conducted via phone, with in-person visits provided for resolving issues.

At the end of eight weeks, individuals from both the groups underwent an assessment with ACE-III, 6MWT, NCPT and QoL-AD. Completion of 80% of the protocol was considered as compliance, to be included in the post treatment analysis.

Statistical analysis

The obtained data was then analysed using Microsoft Excel and SPSS version 16. Data was analysed for the test of normality with K-S Test. Level of significance was kept 5%.

RESULTS

In total there were 32 individuals who participated in the

Table I. Demographic details of the participants.

	Group 1	Group 2
Males	10	9
Females	6	7
Age in years	67.62 (4.06)	65.93 (3.71)
Number of participants having formal education of 12 years or more	16	16

Data of ACE – III and Trail B was not found to be normally distributed; hence non parametric tests were carried out for them.

Table II. Mean values of all the outcome measures.

Outcome measures	Group 1			Group 2		
	Pre values	Post values	Mean difference	Pre values	Post values	Mean difference
	(Mean + SD)	(Mean + SD)	(SD)	(Mean + SD)	(Mean + SD)	(SD)
ACE-III	84.75 (2.74)	89.75 (3.54)	5 (0.80)	85.75 (2.59)	91.25 (3.31)	5.5 (0.72)
Aerobic capacity (ml/kg/min)	12.9 (1.08)	13.94 (0.98)	1.04 (0.56)	12.16 (0.74)	12.52 (0.90)	0.90 (0.58)
QoL - AD	37.68 (3.94)	40 (3.63)	2.32 (0.31)	41.12 (5.5)	43.43 (4.30)	2.31 (1.2)
NCPT - Immediate recall	14.68 (3.59)	16.62 (2.87)	1.94 (0.72)	14.43 (3.86)	16.62 (3.03)	2.19 (0.83)
NCPT - Dual search	32.31 (5.70)	35.43 (4.77)	3.12 (0.93)	28.87 (5.84)	32.31 (5.74)	3.44 (0.1)
NCPT - go – no go	694.31 (183.38)	634.37 (202.84)	59.94 (19.46)	622.12 (106.55)	523.12 (117.30)	99 (10.75)
NCPT - scale balance	5.68 (5.81)	8.75 (5)	3.07 (0.81)	5.06 (2.95)	7.93 (2.90)	2.87 (0.05)
NCPT - trail B	113.75 (60.30)	94.06 (41.33)		126.5 (60.12)	113.75 (52.42)	
NCPT - delayed recall	12.81 (3.37)	15.31 (3.03)	2.5 (1.36)	12.87 (3.36)	15.37 (3.00)	2.5 (1.26)

*SD: standard deviation; ACE-III: Addenbrook's Cognitive Examination – III; QoL-AD: Quality of Life – Alzheimer's disease; NCPT: Neuro Cognitive Performance Test.

Table III. Shows within group analysis of both groups

Outcome measure	Group 1			Group 2		
	Z/t value	p value	Effect size r/d	Z/t value	p value	Effect size r/d
ACE-III	Z= 3.526	< 0.01	0.623	Z = 3.526	< 0.01	r = 0.623
Aerobic capacity	t= 7.413	< 0.01	1.04	t = 2.91	0.011	d = 0.44
QoL - AD	t= -4.498	< 0.01	0.63	t = -4.299	0.001	d = 0.53
NCPT - immediate recall	t= -5.23	< 0.01	0.67	t = -6.591	< 0.01	d = 0.72
NCPT - dual search	t= -6.603	< 0.01	0.65	t = -8.646	< 0.01	d = 0.59
NCPT - go – no go	t= 2.562	0.022	0.32	t = 4.695	< 0.01	d = 0.92
NCPT - scale balance	t= -7.240	< 0.01	0.61	t = -6.191	< 0.01	d = 0.98
NCPT - trail B	Z= 3.185	0.001	-0.563	Z = 3.521	< 0.001	r = -0.623
NCPT - delayed recall	t= -7.319	< 0.01	0.75	t = -7.906	< 0.01	d = 0.83

*SD: standard deviation; ACE-III: Addenbrook's Cognitive Examination – III; QoL-AD: Quality of Life – Alzheimer's disease; NCPT: Neuro Cognitive Performance Test.

Table IV. Shows between group analysis.

Outcome measure	Z/t value	p value	Effect size r/d
ACE-III	Z = 0.81	0.42	r = -0.14
Aerobic capacity	t = 0.232	0.171	d = 0.082
QoL - AD	t = 2.75	0.553	d = 0.00
NCPT - immediate recall	t = -0.503	0.775	d = 0.17
NCPT - dual search	t = -0.83	0.445	d = 0.17
NCPT - go – no go	t = -1.240	0.614	d = 0.43
NCPT - Scale balance	t = 0.299	0.585	d = 0.10
NCPT - Trail B	Z = -0.302	0.78	r = 0.05
NCPT - Delayed Recall	t = 0.052	0.821	d = 0.00

*SD: standard deviation; ACE-III: Addenbrook's Cognitive Examination – III; QoL-AD: Quality of Life – Alzheimer's disease; NCPT: Neuro Cognitive Performance Test.

study. Each group had 16 participants. Table I shows demographic details of the participants.
Table II shows mean values of all the outcome measures.

DISCUSSION

The study was carried out to find out and compare the effect of aerobic exercise training and cognitive training through mobile application on level of cognition, aerobic capacity and quality of life in older adults.
It shows that both the groups showed significant improvements in level of cognition assessed through ACE-III as well as NCPT. But there was no significant difference on comparison of both the groups. Isabel Gomez-Soria et al. found that cognitive stimulation program for older adults with mild cognitive impairment effectively enhanced cognitive function, with improvements sustained at a 6-month follow-up. The program also temporarily improved basic daily living abilities, though it did not significantly affect instrumental activities of daily living, anxiety, or depression levels. No adverse effects were reported [17].
Basak C. et al. found that strategy-based video games improved older adults' cognitive functions and facilitated transfer to other tasks, particularly those requiring attention switching. However, the transfer effect was weaker for tasks needing greater memory capacity. They noted that improvement in lab tasks after gaming itself represents effective training transfer. Similarly, in this study, participants improved cognitive performance through mobile application games [18].
Contrary to these findings, Joseph W. K. et al. reported no significant benefit from commercial cognitive training in young, healthy adults, possibly due to their already high cognitive baseline. In the present study, equal training in exercise and mobile application groups may explain the lack of significant differences between them [19].
Both the group improved in their aerobic capacities. Aerobic exercises improve cardiopulmonary endurance and capacity, supported by meta-analyses. Many of the meta-analysis too reports the same findings as present study. Interestingly, group B, with only cognitive training, also improved aerobic capacity. Kawagoe T. et al. explain this as enhanced brain network efficiency, integrating information better. Training across cognitive domains may have boosted overall brain function, improving everyday activities and physical performance, leading to increased aerobic capacity [15,20].
Both groups improved in QoL-AD scores also. Genoveva Montoya-Murillo et al. found that cognitive rehabilitation program enhanced cognition, quality of life, and reduced apathy and subjective complaints in elderly participants. These findings support the integration of structured cognitive rehabilitation interventions in addressing cognitive and emotional needs in older adults, underscoring their potential to improve overall

well-being [4]. Teixeira et al. found that cognitive stimulation program led to clinically significant improvements in cognition, quality of life, and functional skills among older adults with dementia, even though these changes were not statistically significant. Observations by healthcare providers highlighted better social interactions, behaviours, and engagement in daily routines [22,23].

In this study, mobile application games required quick decisions, focus switching, attention, and short-term memory, stimulating frontal lobe functions. These skills are similar to those needed in daily tasks, such as navigation, cooking, or managing schedules, potentially contributing to improved quality of life. Chao Yang et al. found that video game interventions are effective in improving cognitive functions and performance in older adults, particularly enhancing general cognitive abilities and processing speed and games with higher interactivity and rich visual stimulation provide more significant therapeutic benefits [24]. Present study highlights the importance of assessing and rehabilitating cognitive impairments in older adults to promote functional independence.

Limitations include some participants using computers for the first time during the NCPT, which may have affected results despite familiarization. Non-random convenience sample with random allocation was used, partly due to fewer smartphone users in this age group, and had more male participants than females.

Strength is the culturally adapted ACE-III for Gujarati population, following WHO protocols. Therapists delivering aerobic training were blinded to the study, and exercises were supervised. The mobile app's use of diverse cognitive games also ensured better compliance. Future studies could include longer follow-ups, extended treatment durations, and functional MRI to track cerebral changes linked to cognitive improvement. Research could also explore these interventions in populations with traumatic brain injury, stroke, or Parkinson's disease.

CONCLUSIONS

For level of cognition, aerobic capacity and quality of life both aerobic exercise and cognition training with mobile application are equally effective for older adults having mild cognitive impairments. Aerobic training showed better results in improving aerobic capacity compared to mobile app training.

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Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

DS: conceptualised the work, contributed significantly to the content development, literature review, and formatting the final version for submission, ensuring alignment with academic and publishing standards and led the coordination and review process throughout all stages of the project; MS: provided critical inputs in manuscript development and clinical applicability of the topic. She also assisted in editing and refining the manuscript; DD: was involved in compiling relevant data.

Ethical considerations

The ethics approval was obtained from Institutional Ethics Committee of Ahmedabad Institute of Medical Sciences with ethics approval number AIMS/2016/75 and from Sharda College of Physiotherapy with ethics approval number SCP/2017/001.

The study has been registered with Clinical Trial Registry of India with registration number CTRI/2018/01/011090. The study was conducted over a period of three years.

References

1 Ministry of Statistics and Program Implementation, Government of India. Available from: https://mospi.gov.in

2 Boss G, Seegmiller E, Jolla L. Age-related physiological changes and their clinical significance. J Geriatr Med 1981;6:135.

3 Alcedo J, Flatt T, Pasyukova E. The role of the nervous system in aging and longevity. Front Genet 2013;4:124. https://doi.org/10.3389/fgene.2013.00124

4 O'Sullivan S, Schimtz T, Fulk G. Physical rehabilitation. 6th ed. Delhi: Jaypee India 2014, pp. 1222-1265.

5 Ross R. Principles of neurology. 6th ed. Adams RD, Victor M, Ropper AH, Eds. McGraw Hill 1997, p. 1618. Can J Neurol Sci 1997;24:363. https://doi.org/10.1017/s0317167100033114

6 Mograbi DC, Faria CA de, Fichman HC, et al. Relationship between activities of daily living and cognitive ability in a sample of older adults with heterogeneous educational level. Ann Indian Acad Neurol 2014;17:71-76. https://doi.org/10.4103/0972-2327.128558

7 Palmer K, Winblad B. Mild cognitive impairment: continuing controversies. Nat Clin Pract Neurol 2007;3:111-119. https://doi.org/10.1038/ncpneuro0427

8 Hsieh S, Schubert S, Hoon C, et al. Validation of the Addenbrooke's Cognitive Examination III in frontotemporal dementia and Alzheimer's disease. Dement Geriatr Cogn Disord 2013;36:242-250. https://doi.org/10.1159/000351765

9 Sharma DA, Chaudhary P, Sheth M, et al. Translation, cultural adaptation and validation of ACE III for assessment of cognition for Gujarati population. J Clin Diagn Res 2018;12:VC11-VC14. https://doi.org/10.7860/JCDR/2018/30694.11696

10 Charernboon T, Jaisin K, Lerthattasilp T. The Thai version of the Addenbrooke's Cognitive Examination III. Psychiatry Investig 2016;13:571. https://doi.org/10.4306/pi.2016.13.5.571

11 Morrison GE, Simone CM, Ng NF, et al. Reliability and validity of the Neuro Cognitive Performance Test, a web-based neuropsychological assessment. Front Psychol 2015;6:1652. https://doi.org/10.3389/fpsyg.2015.01652

12 Nguyen L, Murphy K, Andrews G. Cognitive and neural plasticity in old age: a systematic review of evidence from executive functions cognitive training. Ageing Res Rev 2019;53:100912. https://doi.org/10.1016/j.arr.2019.100912

13 Revelo Herrera SG, Leon-Rojas JE. The effect of aerobic exercise in neuroplasticity, learning, and cognition: a systematic review. Cureus 2024;16:E54021. https://doi.org/10.7759/cureus.54021

14 Gheysen F, Poppe L, DeSmet A, et al. Physical activity to improve cognition in older adults: can physical activity programs enriched with cognitive challenges enhance the effects? A systematic review and meta-analysis. Int J Behav Nutr Phys Act 2018;15:63. https://doi.org/10.1186/s12966-018-0697-x

15 Kawagoe T, Onoda K, Yamaguchi S. Associations among executive function, cardiorespiratory fitness, and brain network properties in older adults. Sci Rep 2017;7:40107. https://doi.org/10.1038/srep40107

16 American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 8th ed. Indianapolis: American College of Sports Medicine 2014.

17 Gomez-Soria I, Peralta-Marrupe P, Plo F. Cognitive stimulation program in mild cognitive impairment: a randomized controlled trial. Dement Neuropsychol 2020;14:110-117. https://doi.org/10.1590/1980-57642020dn14-020003

18 Klimova B, Valis M. Smartphone applications can serve as effective cognitive training tools in healthy aging. Front Aging Neurosci 2018;9:436. https://doi.org/10.3389/fnagi.2017.00436

19 Joseph W, Kathleen CM, Mary F, et al. No effect of commercial cognitive training on brain activity, choice behavior, or cognitive performance. J Neurosci 2017;37:7390-7402. https://doi.org/10.1523/JNEUROSCI.2832-16.2017

20 da Silva TBL, Dos Santos G, Moreira APB, et al. Cognitive interventions in mature and older adults, benefits for psychological well-being and quality of life: a systematic review study. Dementia Neuropsychologia 2021;15:428-439. https://doi.org/10.1590/1980-57642021dn15-040002

21 Montoya-Murillo G, Ibarretxe-Bilbao N, Peña J, et al. Effects of cognitive rehabilitation on cognition, apathy, quality of life, and subjective complaints in the elderly: a randomized controlled trial. Am J Geriatr Psychiatry 2020;28:518-529. https://doi.org/10.1016/j.jagp.2019.10.011

22 Teixeira CM, Ribeiro P, Vasconcelos-Raposo J. The impact of cognitive stimulation in older adults with dementia. Psychtech Health J 2024;8:14-25. https://doi.org/10.26580/pthj.art70-2024

23 Toh HM, Ghazali SE, Subramaniam P. The acceptability and usefulness of cognitive stimulation therapy for older adults with dementia: a narrative review. Int J Alzheimers Dis 2016;2016:5131570. https://doi.org/10.1155/2016/5131570

24 Yang C, Han X, Jin M, et al. The effect of video game–based interventions on performance and cognitive function in older adults: Bayesian network meta-analysis. JMIR Serious Games 2021;9:E27058. https://doi.org/10.2196/27058