



The effect of a multicomponent exercise program on cognitive function and functional ability in community dwelling older adults

Haripriya S^{*1}, Dhanesh Kumar K U², Sanjay Eapen Samuel¹, Ajith S³

¹Laxmi Memorial College of Physiotherapy, A.J Towers, Balmatta, Mangaluru, Karnataka, India

²Nitte Institute of Physiotherapy, Nitte University, Nithyananda Nagar P.O, Mangaluru, Karnataka, India

³Department of Health Rehabilitation Sciences, College of Applied Medical Sciences, Shaqra University, Kingdom of Saudi Arabia

Article History:

Received on: 09.04.2019

Revised on: 14.07.2019

Accepted on: 19.07.2019

Keywords:

geriatrics,
aged,
community dwelling,
cognition,
activities of daily living,
exercise

ABSTRACT

Normal aging results in alterations in the structure and function of the brain, causing impairment in cognitive function and dependency in performing activities of daily living. A multicomponent physical activity program has been recommended to maintain physical and cognitive function in elderly individuals. The present study aimed at measuring the effect of such an exercise program on the cognitive function and activities of daily living (ADL) function in community dwelling elderly individuals. 52 elderly adults living in the community and ambulating independently were selected purposively and underwent a 10-week multi-component exercise program which included aerobic exercise, strength training, balance exercises and functional training. The participants were assessed using the Mini-Mental State Examination (MMSE) and Barthel Index (BI) at baseline and every two weeks up till 10 weeks. The data obtained was analysed using descriptive statistics and t-test for finding the effect of the intervention program on the outcome measures. The results showed a significant difference in the pre- to post-intervention scores of both the outcome measures. A multicomponent exercise program was seen to be effective in improving the cognitive function and level of ADL activity in community dwelling elderly individuals. Such an exercise program should be recommended to all elderly adults in order to maintain their cognitive and overall functioning and to improve their productivity.



*Corresponding Author

Name: Haripriya S

Phone: +91- 9886112351

Email: haripriyaajithsoman@gmail.com

ISSN: 0975-7538

DOI: <https://doi.org/10.26452/ijrps.v11i1.1793>

Production and Hosted by

IJRPS | www.ijrps.com

© 2020 | All rights reserved.

INTRODUCTION

Aging is an on-going process of life, that has to be faced with pride, security and dignity. The number of persons aged 60 years and above in developing countries is expected to be 1600 million by 2050. A huge number of older persons is living with a disability, a consequence of accumulated health risks across a lifespan of diseases, injury and chronic illness. It is said that healthy diet and physical activity should not only start early in life but also continue into old age, as progressing age puts people at risk of non-communicable diseases and cognitive impairments such as Alzheimer's disease and dementia ([Report on the Status of Elderly in Select](#)

States of India, 2011).

The physiological changes of aging and those related to inactivity in elderly people commonly lead to loss of physical function and cause inability or dependence in performing activities of daily living (ADL), thus reducing longevity and quality of life (Chou *et al.*, 2012). Normal aging results in alterations in the structure and function of the brain, resulting in changes in cognitive function. As the number of elderly people in the world increases, the number of older people with impaired cognitive function also increases correspondingly. (Kirk-Sanchez and Mcgough, 2013). A major challenge for health-care professionals who are involved with care of the elderly would be to maintain an optimal cognitive function and functional status, as this would play a major role in keeping up the independence and productivity of the elderly person.

Atrophy of the human brain starts to occur when a person is in his twenties, and this atrophy happens in a non-uniform manner in the temporal, parietal and frontal areas of the brain, the frontal lobe suffering a disproportionately higher rate of atrophy. The frontal lobe is largely responsible for performing executive functions, and atrophy in that part leads to problems with multitasking or attention switching, slower response and reaction times, reduced inhibitory control, and difficulty in executing ADL, especially instrumental ADL (Glisky, 2007).

The changes associated with normal cognitive ageing have been well studied. Some aspects of cognitive function, like memory, processing speed and conceptual reasoning, are affected severely, whereas other aspects like vocabulary remain intact, or are even enhanced somewhat with aging (Harada *et al.*, 2013).

Cognitive aging is the decline in cognitive processing as people get older. It can affect several cognitive functions such as learning, processing speed, memory, understanding and decision making and is an aspect of aging, which is increasing in importance as the number of older adults increase. Prevention and treatment of cognitive decline through different strategies is the need of the hour. Different approaches have been used for this, an important one of which is physical exercise (Zhang *et al.*, 2018).

The American College of Sports Medicine (ACSM) and American Heart Association (AHA) have recommended a multicomponent physical activity program including aerobic fitness, muscle strengthening, flexibility and balance exercises for elderly people which should be tailor-made individually with the special needs of the elderly in mind. Addi-

tionally, specific exercises such as those to improve agility and proprioception should be given to people who have an increased fall risk or problems with mobility (Nelson *et al.*, 2007).

Exercise can slow down the physiological changes seen in aging, improve performance in ADL, can improve cognitive function, and can complement the management of chronic diseases in the elderly. According to Chon C and co-workers, exercise, previously thought to be dangerous for the elderly, especially frail elderly, has recently been proved to be safe and effective if performed with the necessary precautions. The available evidence about the effect of exercise on cognitive functions is mixed, some studies showing massive improvement, while others, modest improvement, and still others, none at all (Kirk-Sanchez and Mcgough, 2013).

Keeping in mind the significance of cognitive and daily living functions and the fact that a vast majority of Indian elderly live in the community, the present study aimed to examine the effect of a 10-week multicomponent exercise program consisting of aerobic, strengthening, balance and functional training on the cognitive function and ADL performance in community dwelling elderly adults.

METHODOLOGY

The study was conducted on 52 participants, selected purposively from elderly adults living at home in areas in and around Mangalore, South India. The study was part of a larger quasi-experimental study with similar objectives. Ethical clearance was obtained from the Institutional Ethical Committee of Nitte University, India. Participants were included if they were aged at least 65 years, were community-dwelling, were able to ambulate independently and understand instructions. We excluded those with severe cardiopulmonary diseases, severe psychiatric illness, including medically unresponsive depression and dementia, and those with acute neurological impairment such as Parkinson's disease and acute stroke. Also excluded were those with other severe physical illness like severe joint pains, uncontrolled hypertension or diabetes mellitus, recent unhealed fracture, acute myocardial infarction or terminal illness and those who had any other contraindications to performing an exercise.

The participants were assessed at baseline using the Mini-Mental State Examination (MMSE) and Barthel Index (BI), following which they underwent a partially supervised multicomponent exercise program, comprising of aerobic exercise, functional training, balance training and muscle strengthening, of 10

weeks duration. The outcome measurement was repeated every two weeks till the end of the intervention program.

89 elderly individuals were screened for inclusion in the study, out of which 16 declined to participate, and 14 were excluded for not fulfilling the criteria (joint pains limiting exercise=5, unwilling to participate=3, sub-acute/ chronic stroke with residual neurological deficit=4, unable to follow instructions=2). Data has been collected from 52 subjects after discounting seven persons who dropped out of the exercise program citing lack of interest. The collected data was analysed statistically using appropriate tests.

Intervention

The selected participants received a partially supervised multi-component exercise protocol consisting of progressive resisted exercises, balance exercises, functional training and aerobic exercise for three days a week for 10 weeks (Nelson *et al.*, 2007). One session a week was supervised by the principal investigator, and a weekly phone call was made to ensure compliance on the remaining days of the week. The exercise program had the following components,

Progressive resisted training

Given for major muscle groups of the upper limb and lower limb at 40-80% of 1 repetition maximum, 1-3 sets of 8 repetitions using free weights. Theraband exercises, isometric exercises and functional resisted exercises like wall push-ups, squats and lunges were included progressively (Leenders *et al.*, 2013).

Balance training

Progressively challenging balance exercises adjusted to individual needs, like standing with feet together, tandem standing, perturbations and obstacle courses (Paw *et al.*, 2006).

Functional training

Exercises designed to improve functional activities, like walking, stepping, transfers, mat exercises and catching and throwing a ball. The intensity of the exercises was increased based on individual needs and abilities (Halvarsson *et al.*, 2013).

Aerobic training

15-60 minutes of continuous or discontinuous aerobic activity, at 55-90% of maximal heart rate progressed in intensity gradually (Blumenthal *et al.*, 1989).

In addition to the above, a warm-up and cool-down period was incorporated into the session, where the

subject did low-level aerobic exercise and general mobility exercises of the neck, trunk, upper limbs and lower limbs. The exercise session was of a duration of 1 hour, with frequent breaks as necessary.

If the participant reached the maximum expected level of fitness expected for the age and gender, then maintenance exercises were given till the end of ten weeks.

Outcome measures

Mini-Mental State Examination(MMSE)

Designed by Folstein and Folstein (1975), the MMSE is a reliable and valid tool, with high specificity, which is extensively used in clinical practice worldwide. The MMSE is scored out of 30 and takes approximately ten minutes to complete. It includes 10 questions on orientation to time and place, immediate verbal recall of 3 words to measure registration, a serial subtraction task (subtracting sevens from one hundred), memory (delayed verbal recall of 3 words), naming, language (repeat a phrase, follow a three-step command, write a sentence) and drawing (copying a line drawing of overlapping pentagons). The copyright of the MMSE is presently owned by the Psychological Assessment Resources (PAR), from whom the scale was purchased in order to use for this study.

Barthel Index(BI)

The BI measures the extent to which someone can function independently and has mobility in their activities of daily living. A five-point scale with a maximum total score of 100, it is an ordinal scale assessing ten activities of daily living, namely, feeding, bathing, grooming, dressing, bowel control, bladder control, toileting, chair transfer, ambulation and stair climbing. The reliability and validity of the BI has been established in various populations, including elderly individuals (Sainsbury *et al.*, 2005).

RESULTS AND DISCUSSION

Data obtained from 52 elderly persons, 33 men and 19 women with mean age 71.8 ± 4.6 were analysed. Descriptive statistics (mean and standard deviation) were used to tabulate MMSE and BI scores at baseline and every two weeks during the intervention. The paired t-test was used to test the significance of the difference in means between the baseline and post-intervention scores of both the outcome measures.

Table 1 depicts the descriptive statistics of the MMSE and Barthel Index scores taken at Baseline and at the end of weeks 2, 4, 6, 8 and 10.

Table 1: Descriptive statistics of outcome measures

	MMSE	BI
Week 0	20.67±1.97	68.94±4.57
Week 2	20.94±1.92	69.81±4.42
Week 4	21.19±1.79	70.77±4.13
Week 6	21.63±1.76	72.31±4.25
Week 8	22.05±1.72	73.94±4.57
Week 10	22.53±1.6	75.00±4.20

Table 2: Pairwise comparisons of MMSE and BI scores at different points of time

I factor	J factor	BI		MMSE	
		Mean Difference (I-J)	Sig (p)	Mean Difference (I-J)	Sig. (p)
0	2	-.865	.029	-.269	.009
	4	-1.827	.000	-.519	.000
	6	-3.365	.000	-.962	.000
	8	-5.000	.000	-1.385	.000
	10	-6.058	.000	-1.865	.000
2	4	-.962	.015	-.250	.000
	6	-2.500	.000	-.692	.000
	8	-4.135	.000	-1.115	.000
	10	-5.192	.000	-1.596	.000
4	6	-1.538	.000	-.442	.000
	8	-3.137	.000	-.856	.000
	10	-4.231	.000	-1.346	.000
6	8	-1.635	.000	-.423	.000
	10	-2.692	.000	-.904	.000
8	10	-1.058	.008	-.481	.000

Table 2 depicts the pairwise comparison of Barthel Index and MMSE scores at different points of time. Comparisons were made between all the points of time at which the readings were taken, i.e., the 2nd, 4th, 6th, 8th and 10th weeks. There was a significant improvement seen between all points of time, except baseline and second week for both BI and MMSE scores, and second to the fourth week and eighth to tenth week for BI scores.

Table 3 shows the comparison of means of the MMSE and BI scores at baseline and at the end of the ten weeks intervention. There was seen to be a statistically significant difference between the pre and post-test scores, as revealed by the results of the t-test (p<.001)

The study was undertaken to understand the effectiveness of a multi component exercise program on the cognitive function and activities of daily living of community dwelling elderly individuals. The results showed a highly significant effect of the intervention program on both the outcome measures.

These changes were seen as early as two weeks into the intervention, and with each passing week, the improvement increased in quantum. This suggests that any exercise, no matter how less in duration, is better than none, and more is definitely better than less. There were no adverse outcomes reported in the participants, though the enrollment rate was less and the dropout rate high, possibly due to the relatively long duration of intervention. The exercises are given, as well as the outcome measures used, were simple and inexpensive and could be performed in the community easily.

Physical exercise has been known to be a very strong gene modulator which has been known to induce positive changes on the structure and function of the brain. One of the mechanisms by which this is brought about could be by enhancing neuroplasticity. A review conducted by Mandolesi et al. in 2018 showed that exercise has been linked with improved cognitive functions in all age groups. Memory, attention, executive functioning and aca-

Table 3: Comparison of means of MMSE and BI scores pre- and post-intervention

Outcome measure	Pre-post mean difference	T	P
MMSE	-1.87±1.43	-9.42	.000
BI	-6.06±3.75	-11.65	.000

demographic performance were some of the areas found to change positively when exercise was performed. In older adults, exercise has been seen to decrease the extent of cognitive decline with aging, reduce the risk of decreased executive function, dementia and improve quality of life in general.

There are two possible mechanisms by which cognitive functioning can be improved with physical exercise. One, exercise can improve circulation of blood to the neural circuits which are involved in cognitive functioning. Another explanation is given in the concept of “cerebral reserves”, by the extent of which different persons age differently in cognitive function, though the extent and nature of neurodegenerative changes are similar. There are two recognized forms of cerebral reserves: cognitive reserve and brain reserve. Out of these, exercise is thought to improve cognitive reserves by enhancing the connectivity between neural circuits, providing more reserves to be spent in the event of a neural pathology, thus providing a neuroprotective effect.

The significant improvement seen in the cognitive function of the participants of the present study highlight the importance of regular exercise on the cognitive and physical functioning of elderly adults living in the community. In a society where exercise for older adults is considered as unnecessary or even dangerous, in spite of all the evidence available regarding it, there is a real need for awareness programs, both among clinicians and among elderly persons and their caregivers, about the beneficial effects of exercise on the body and mind of elders.

The exercise program given in the present study might have had a direct effect on the ADL function of the participants, as strength, balance and aerobic capacity, which were components of the exercise program, can influence ADL function considerably. Exercise training, especially that involving functional training or task-oriented training, has been shown to improve ADL. The outcome of such training can be highly motivating to the elders performing them and thus can help in improving functional levels (Peri et al., 2007).

Physical exercise of the correct intensity and duration is an important non-pharmacological intervention which can modulate the cognitive as well as the overall functioning of elderly adults. This is espe-

cially important since polypharmacy leads to complications in older adults, and is considered as a risk for falls in the elderly. An exercise program such as the one given in the present study should be recommended to all elderly adults in order to maintain their cognitive and overall functioning and to improve their productivity.

The study was with a small number of limitations. The MMSE was used as a measure of cognitive function, and not specific tests of executive function like the Trail Making Test. More objective measures such as neuroimaging techniques were also not used for measuring cognitive function. The duration of the intervention program was only 10 weeks, which was done in order to improve compliance; an exercise program of up to 6 months duration could have possibly increased the quantum of improvement in the participants. There was no long term follow up done on the participants to measure the sustainability of the obtained results.

CONCLUSIONS

A multicomponent exercise program comprising of aerobic training, balance exercises, strengthening exercises and functional training can significantly improve the cognitive status and ADL function of elderly adults living in the community.

REFERENCES

- Blumenthal, J. A., Emery, C. F., Madden, D. J., George, L. K., Coleman, R. E., Riddle, M. W., Williams, R. S. 1989. Cardiovascular and Behavioral Effects of Aerobic Exercise Training in Healthy Older Men and Women. *Journal of Gerontology*, 44(5):147-157.
- Chou, C. H., Hwang, C. L., Wu, Y. T. 2012. Effect of Exercise on Physical Function, Daily Living Activities, and Quality of Life in the Frail Older Adults: A Meta-Analysis. *Archives of Physical Medicine and Rehabilitation*, 93(2):237-244.
- Folstein, M., Folstein, S. 1975. A practical method for grading the cognitive state of patients for the clinician. *J Psychiatr Res*, 12(3):189-98.
- Golisky, E. L. 2007. Changes in cognitive function in human aging. Brain aging: Models, methods, and mechanisms. pages 3-20.

- Halvarsson, A., Franzén, E., Farén, E., Olsson, E., Oddsson, L., Ståhle, A. 2013. Long-term effects of new progressive group balance training for elderly people with increased risk of falling - a randomized controlled trial. *Clinical Rehabilitation*, 27(5):450–458.
- Harada, C. N., Love, M. C. N., Triebel, K. L. 2013. Normal Cognitive Aging. *Clinics in Geriatric Medicine*, 29(4):737–752.
- Kirk-Sanchez, N., MCGough, E. 2013. Physical exercise and cognitive performance in the elderly: current perspectives. *Clinical Interventions in Aging*, 9:51–62.
- Leenders, M., Verdijk, L. B., Hoeven, L. V. D., Kranenburg, J. V., Nilwik, R., Loon, L. J. C. V. 2013. Elderly Men and Women Benefit Equally From Prolonged Resistance-Type Exercise Training. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 68(7):769–779.
- Nelson, M. E., Rejeski, W. J., Blair, S. N., Duncan, P. W., Judge, J. O., King, A. C., Castaneda-Sceppa, C. 2007. Physical Activity and Public Health in Older Adults. *Medicine & Science in Sports & Exercise*, 39(8):1435–1445.
- Paw, M. J. M. C. A., Van Poppel, M. N. M., Van Mechelen, W. 2006. Effects of resistance and functional-skills training on habitual activity and constipation among older adults living in long-term care facilities: A randomized controlled trial. *BMC Geriatrics*, 6(9).
- Peri, K., Kerse, N., Robinson, E., Parsons, M., Parsons, J., Latham, N. 2007. Does functionally based activity make a difference to health status and mobility? A randomised controlled trial in residential care facilities (The Promoting Independent Living Study; PILS). *Age and Ageing*, 37(1):57–63.
- Report on the Status of Elderly in Select States of India 2011. Building Knowledge Base on Ageing in India. In and others, editor, *BKPAI*. Accessed 15 July 2019.
- Sainsbury, A., Seebass, G., Bansal, A., Young, J. B. 2005. Reliability of the Barthel Index when used with older people. *Age and Ageing*, 34(3):228–232.
- Zhang, Y., Li, C., Zou, L., Liu, X., Song, W. 2018. The Effects of Mind-Body Exercise on Cognitive Performance in Elderly: A Systematic Review and Meta-Analysis. *International Journal of Environmental Research and Public Health*, 15(12):2791–2791.