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Therapeutic effects of home-based exercise of geriatrics for the management of cognitive impairment

Research article

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Abstract

Background: Cognitive impairment is when a person has trouble remembering, learning new things, concentrating, or making decisions that affect their everyday life. Aging is the accumulation of changes in an organism or object over time. It also causes deterioration in various aspects of cognitive function. This decline in cognitive ability is attributed to decreased physical activity in elderly. Mild cognitive impairment is an emerging term that encompasses the clinical state between normal cognition and dementia in elderly people.

Objective: The objective of the study is to find out the effect of home based aerobic exercise on cognition in elderly subjects with mild cognitive impairment.

Method: 30 subjects were included in this study. Each subject was assigned into two groups by simple random sampling. The outcome measure Montreal cognitive assessment scale was used for both the groups. Treatment intervention used for the experimental group was moderate intensity aerobic exercise program i.e. walking and control group received active range of motion exercises and stretching exercises.

Results: In experimental group there was a significant improvement in cognitive function. The percentage change in Montreal Cognitive Assessment scale for experimental group was 4.02% with a highly significant p value (p=0.004).

The control group showed no improvement in cognitive function. The percentage change in control group was -3.61%.

Conclusion: This study demonstrates the efficacy of aerobic training on cognition in elderly subjects with mild cognitive impairment. The results of the present study suggest that aerobic exercises should be promoted as part of a healthy lifestyle in elderly people and those with mild cognitive impairment.

Key Words: Mild cognitive impairment, Aerobic exercise, Elderly, Cognition

Introduction

Aging is the accumulation of changes in an organism or object over time. Aging in human refers to a multidimensional process of physical, psychological and social change [1].

Aging is associated with many degenerative changes in the body. Compensatory mechanisms often exist and impairment does not always result, although some loss of function in some system is almost inevitable [2].

The brain unlike other organs has limited capacity for recovery after insult. The intrinsic insult includes an accumulation of neurofibrillary tangles, senile plaques and large amount of amyloid protein, changes that are associated with dementia and cognitive impairment. Extrinsic insult includes vascular changes leading to hypertension and stroke which is secondary to age related changes [3].

Two thirds of all people eventually experience some significant loss of mental lucidity and independence as a result of aging. People of 60 years and older experience significant cognitive decline, including decline in memory, concentration, clarity of thought, focus and judgment with an increase in the onset of several neurological problems like Alzheimer's disease, Parkinson's disease, Stroke etc [4].

Research has shown that as brain ages or as people get older, there will be a decrease in brain weight and brain volume, widening of the grooves on the surface of the brain and enlargement of the ventricular system. The decrease in brain weight and brain volume is due to loss of neurons and extracellular fluid. Enlargement of the ventricular system may be probably due to loss of cells surrounding the ventricles [5].

Aging produces a change in the ability to participate in physical activity and also change in cognitive function. Mild Cognitive Impairment is one of the entities referring to elderly persons with subclinical cognitive deficit [6].

"Mild cognitive impairment is a diagnosis given to individuals who have cognitive impairments beyond that expected for their age and education, but that do not interfere significantly with their daily activities" [7,8].

Finally, though there are so many studies done on effect of physical activity on cognitive function in normal elderly subjects, no studies have been carried out involving specifically people with MCI to assess the effect of physical training on their cognitive capacities and cognitive decline. It still remains unclear whether aerobic exercises accounts for the effect on cognitive capacity in MCI subjects. Hence the present study intends to investigate the effectiveness of aerobic exercise on cognitive function in elderly subjects who have already developed mild cognitive impairment.

Objective of the study

The objective of this study is to find out the effect of home based aerobic exercise on cognition in elderly subjects with mild cognitive impairment.

Materials and methods

NIMHANS, Bangalore

Method of collection of data

Population : Elderly subjects with mild cognitive impairment.

Sample design : Simple Random Sampling.

Sample size : 30

Type of Study : Experimental-control study with pre and post test design.

Inclusion criteria

1. Subjects diagnosed with mild cognitive impairment by a neuropsychiatrist.
2. Subjects who are in the age group of 60-70 years of both gender.
3. Subjects who will be able to follow the test protocols.
4. Subjects who will be able to walk independently without making use of assistive devices.

Exclusion criteria

1. Subjects who are non co-operative.
2. Subjects with cardiac and respiratory disorders.
3. Subjects who cannot participate because of other neurological impairments.
4. Subjects who cannot participate because of musculoskeletal disorders.

Materials required

1. Montreal cognitive assessment chart
2. Watch
3. Pencil
4. Eraser
5. Assessment sheet

Methodology

Subjects who were diagnosed by a Neuropsychiatrist as having mild cognitive impairment were asked to give a written/ informed consent. They were screened for inclusion and exclusion criteria and those who fulfilled all the inclusion criteria were included in the study.

The 30 subjects were divided into experimental and control group based on simple random sampling and 15

subjects were included in each group. The sequence of intervention as follows:

Prior to the intervention

Pre-test cognitive function evaluation for both the groups was done using Montreal Cognitive Assessment scale which includes following items- 1.Visuospatial and Executive functions 2.Conceptual thinking 3.Memory 4.Attention 5.Language 6.Abstraction 7.Orientation.

All the subjects of both the group underwent stress test using Naughton protocol as a safety measure.

After the pre-test evaluation subjects were taken for intervention procedures.

Intervention procedure

The intervention given to the experimental group was moderate intensity aerobic exercise program i.e. walking and for the control group stretching exercises and gentle active range of motion exercises were given. Both the groups were advised to carry out their activities of daily living.

Experimental group

Aerobic intervention included home based aerobic program for duration of 40 to 50 minutes/day. This aerobic program consisted of three components;

Warming up session: for 10 minutes,

Exercise period: Aerobic walking program for 20 to 30 minutes, and Cool down session: for about 10 minutes.

Activities in each session

Warm up and cool down session included stretching exercises and gentle active range of motion exercises to larger muscle groups like lower limb and trunk muscles.

Exercise period

The exercise was given based on principle of exercise prescription which consists of intensity, frequency, type and duration of exercises.

Type of exercise: Brisk walking was the preferred mode of exercise with intensity 50 to 70% HRmax and RPE of 11 to 14.

Intensity

The training intensity for walking was based on Borg's rate of perceived exertion (RPE) and target heart rate based on karvonen's formula.

Method used to determine exercise heart rate

Percentage of maximum heart rate (depending on level of fitness)

Karvonen's formula (heart rate reserve)

Exercise heart rate= HR max+ 60-70 %(HRmax-HRrest)

Training was given to all patients regarding palpating the pulse and calculating the heart rate and to perceive the Borg's Rating of Perceived Exertion (RPE) for monitoring the intensity.

Frequency

One session per day and continued all the days for a period 8 weeks.

Progression of exercises

Initial session of exercise prescription and training was given under supervision and then the home program protocol was given to the all the subjects to be performed at home for 8 weeks. Follow up was done through phone calls and the subjects were visited once in a week.

Progression was made by increasing the duration depending on subject's adaptation to the exercise. As the subjects became more conditioned to the exercise program, progression of the exercise intensity was done as per their needs. As the RPE was falling down with improving fitness the intensity of exercise was increased at 5 to 10 percent of the maximum heart rate and by maintaining RPE of 11 to 14 throughout the

8 weeks of duration. For the first four weeks exercise training duration was 20 minutes and from fifth to eight-week duration was increased from 20 to 30 minutes.

All the above exercise prescription and protocol training was given according to the "Exercise Standards" A Statement for Healthcare Professionals from the American Heart Association.54

Instructions given to subjects

All the subjects were given an exercise log book which included information pertaining to pulse rate, perceived exertion, frequency, duration, exercise protocols and type of exercise performed.

Subjects were educated regarding signs and symptoms to be monitored while doing exercise programs and the do's and don'ts and the termination criteria for the exercises were explained properly to them.

Subjects were regularly contacted to find whether they are adhering to the exercise program or not by direct home visit or by telephone. Any advice or change in program was given to subjects whenever it was necessary.[8]

Control group

It included home based exercises like gentle active range of motion exercises and stretching exercises to large muscle groups of lower limb and trunk muscles for 20min and advised to carry out their activities of daily living.

Frequency: 20 min/day and continued all the days for a period 8 weeks.

Post test evaluation was done using the outcome measure Montreal Cognitive Assessment scale. The pre and post test data values were analyzed (Figure 1).

Figure 1: Materials used

Figure 2: Walking performed by patient

Outcome measure

Montreal cognitive assessment scale (Figure 2).

Results

Study Design

An experimental study consisting of 30 subjects were randomized into 2 groups; 15 in control group (AROM and stretching exercises), 15 in experimental group (aerobic intervention) is undertaken to study the effect based on MoCA.

As given in the table 1, mean age of experimental group was 64.86 with SD of 2.87 and in control group the mean age was 64.40 with SD of 2.66. Hence the samples are age matched with p= 0.648.

Table 1: Comparison of age distribution

Age in years	Experimental group		Control group		Total	
	No	%	No	%	No	%
60-65	9	60.0	9	60.0	18	60.0
66-70	6	40.0	6	40.0	12	40.0
Total	15	100.0	15	100.0	30	100.0
Mean ± SD	64.86±2.87		64.40±2.66		64.63±2.73	

There are 9 males and 6 females in experimental group and there are 8 males and 7 females in control group. The gender distribution between the two groups is not statistically significant with p = 0.713 (Figure 3)

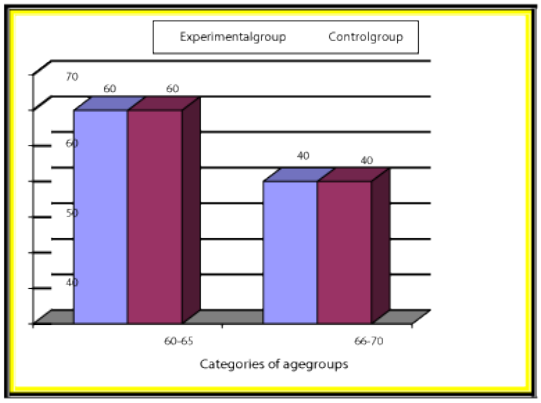

Figure 3: Comparison of age distribution

In this table 2 the pre assessment score on Montreal Cognitive Assessment scale in experimental group is 20.73 with a standard deviation of 1.70 and in control group, mean is 20.93 with a standard deviation of 1.43 score. The pre assessment score in both the group is statistically similar at baseline with p=0.267 (Table 3).

Table 2: Gender distribution of subjects studied

Gender	Experimental group		Control group		Total	
	No	%	No	%	No	%
Male	9	60.0	8	53.3	17	56.7
Female	6	40.0	7	46.7	13	43.3
Total	15	100.0	15	100.0	30	100.0

Table 3: Comparison of Montreal Cognitive Assessment Score At Baseline between Experimental and Control Group

MOCA	Experimental Group	Control Group
Min-Max	(19.0-24.0)	(19.0-24.0)
Mean±SD	20.73±1.70	20.93±1.43

In this table 4 the pre intervention score for experimental group was 20.73 with a standard deviation of 1.70, while the post intervention score was 21.60 with a standard deviation of 1.68. Further statistical analysis showed that within the experimental group there was a strong statistical significance (p=0.004) in MoCA score from pre-intervention to post intervention with a change in percentage of 4.02% (Figure 4 & 5).

Table 4: Comparison of pre intervention and post intervention score of Montreal Cognitive Assessment Scale between Experimental and Control Group.

	Experimental Group	Control Group	Between the group significance
	Mean±SD	Mean±SD	
Pre-intervention	20.73±1.70	20.93±1.43	z=-0.595 p=0.552
Post-intervention	21.60±1.68	20.20±0.94	z=-2.619 p=0.009**
Within the group significance	z=-2.919 p= 0.004**	z=-2.232 p= 0.026*	
Within the group Percentage change from pre to post intervention	4.02%	-3.61%	

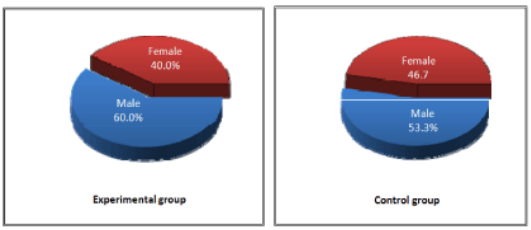

Figure 4: Gender distribution of subjects studied.

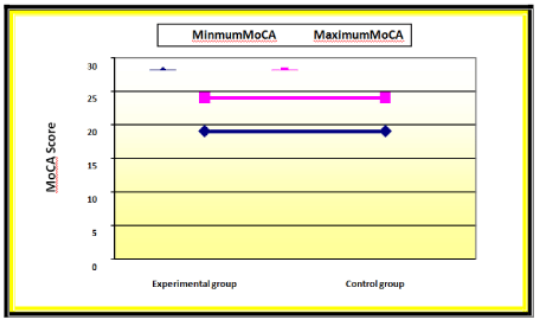

Figure 5: Comparison of MoCA at baseline studied

The pre intervention score for control group was 20.93 with a standard deviation of and post intervention score was 20.20 with a standard deviation of 0.94. Further statistical analysis showed that within the control group there was a statistical significance (p=0.026) in MoCA score from pre-intervention to post intervention with a change in percentage of -3.61%.

When the means of post intervention were compared between the experimental and control group there was a strong statistical significance difference with a p value of 0.009 (Figure 6 & 7).

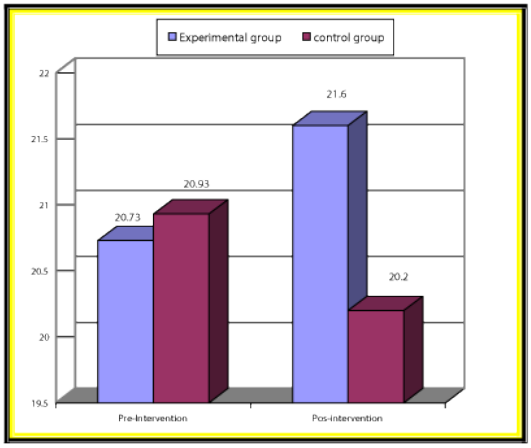

Figure 6: Comparison of pre intervention and post intervention score of Montreal Cognitive Assessment Scale between Experimental and Control Group.

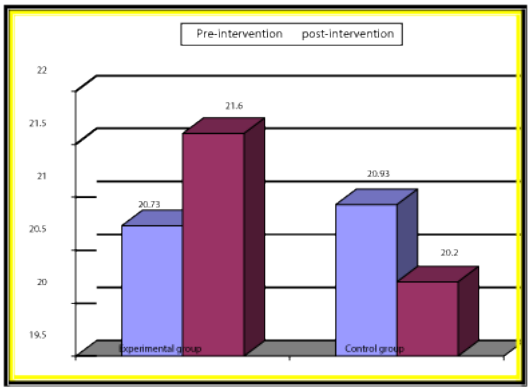

Figure 7: Comparison of pre intervention and post intervention score of Montreal Cognitive Assessment Scale between Experimental and Control Group

Discussion

Over the past decade, there has been increasing focus on the influence of a number of lifestyle factors on the cognitive vitality of older adults [9]. The older population is

growing rapidly and older individuals face late life changes in cognitive function that affect quality of life and increase mortality [10].

The results of the present study are in support of earlier research suggesting that increase in cognitive functions results from participation in moderate intensity physical activity in elderly subjects [11].

Cognitive abilities are the greatest when people are in their 30s and 40s and stays about the same until the late 50s or early 60s, at which point they begin to decline, but to only a small degree. The effects of cognitive changes are not usually noticed until the 70s and beyond [12].

Therefore, the purpose of this study was to find out the effect of an acute bout of moderate aerobic exercise (walking) in home based setting and subsequent cognitive performance in a population sample of elderly adults aged 60 to 70 years with mild cognitive impairment.

Statistical significance was seen within and between experimental and control group following intervention This result supports our hypothesis that aerobic exercises like walking maintains the cognitive function in elderly subjects who are at risk of developing dementia.

The result of the present study is also supported by the findings of Stanley J. Colcombe, Kirk I. Erickson (2003) who conducted a study on healthy individuals to investigate the relationship between aerobic fitness and in vivo brain tissue density inan older adult population. Their results suggest that cardiovascular fitness is associated with the sparing of brain tissue in aging humans. Furthermore, these results suggest a strong biological basis for the role of aerobic fitness in maintaining and enhancing central nervous system health and cognitive functioning in older adults [13].

According to a study done by Stanley J Colcombe, Kirk I. Erickson (2006), participation in an aerobic exercise program increased volume in both gray and white matter primarily located in prefrontal and temporal cortices—those regions that are often reported to show substantial age-related deterioration. This study also suggests that brain volume loss is not an inevitable effect of advancing age and that relatively minor interventions can go a long way in offsetting and minimizing brain volume loss. It also highlights the potential importance of aerobic exercise in not only staving off neural decline in aging humans, but also suggest an effective mechanism to roll back some of the normal age related losses in brain structure. Their findings also confirms the benefits of exercise training on brain volume in aging humans and also compliments on the benefits of exercise on cognition and brain structure such as neuron proliferation and survival, growth of capillary beds, and increased dendritic spines [14].

Additionally, study conducted by Henriette Van Praag H(1999) in nonhuman models suggest that the changes in brain volume seen are likely due to changes in synaptic interconnections, axonal integrity and capillary bed growth [15].

Regular physical activity may reduce serum lipid levels and hypertension and increase cardiovascular fitness [16]., all of which could reduce the risk of vascular dementia and Alzheimer's disease [17]. Indeed, Rogers R L, Meyer JS, Mortel K F (1990) found that active elderly persons had fewer declines in cerebral blood flow during a 4-yearperiod compared with less active elderly persons, a mechanism that might help maintain cognitive function. Another possible mechanism is that physical activity stimulates neurotrophic factors such as BDNF and also promotes neuronal growth, possibly providing reserve against cognitive decline and dementia [18].

These physiological changes seen in normal elderly in the above studies are in support of the results of the present study emphasizing on the importance of aerobic exercise in improving cognitive function in mild cognitive impairment also.

In the present study the group which did not receive aerobic exercise showed no improvement in the cognitive function and also deterioration among few subjects was seen in post assessment score which could be due to the secondary effect of degenerative changes taking place as a result of aging. This result is well supported by Stacey, Kozma, Stones (1985) whose study suggests that decrease in cognitive function, specifically memory, come as a result of the decline in physical health associated with age, not necessarily aging alone. This leads to the decrease in available cognitive resources.

According to study done by Netz, Jacob (1994) exercise is thought to stimulate the central nervous system, making these resources more readily available. For this reason, older adults show stronger improvements in memory resulting from exercise than young or middle-aged adults.

In this study, homogeneity with respect to secondary

variables, that is, age and gender scores were considered, with a view that these confounding variables could have had an influence on the results of the study. The variability in age (p=.648), gender (p=.713) of the subjects were not statistically significant amongst the 2 groups and hence are not believed to have had much effect on the results.

Overall these findings suggest that an acute bout of moderate physical activity results in an increase in cognitive functions specifically memory and executive function. This study demonstrates the positive effects of home-based moderate intensity aerobic exercise on cognition. Thus, these exercises can be prescribed for elderly MCI subjects as a routine intervention.

The results of this trial will provide clinicians in the field of aging with more knowledge about treatment of older persons with cognitive decline. Hence aerobic exercise like walking can be used as an additional intervention method for this target group and also implementation of the walking program is relatively easy.

Conclusion

The novel and intriguing finding of this study shows that 2 months of regular aerobic exercise not only spares cognitive function but also improves the cognitive abilities in elderly subjects with MCI.

Physicians will increasingly see elderly patients with mild memory loss and learning an approach to diagnosing states such as mild cognitive impairment is now warranted. The physiotherapists should be familiar with the criteria for mild cognitive impairment and start to use them in practice.

The clinical implication is that the aerobic exercise is beneficial in improving the cognitive function and it should be promoted as part of a healthy lifestyle in elderly people with mild cognitive impairment.

From this we can conclude that "there will be a significant effect of home-based aerobic exercise on cognition in elderly subjects with mild cognitive impairment."

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