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Original Article

Effect of a Structured Exercise Program in Reducing Falls and Improving Balance and Gait in the Elderly Population Living in Long-Term Care Homes – A Randomized Controlled Trial

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ABSTRACT

Background/Purpose: Fall is one of the serious health issues for the elderly population. The co-morbidities arise from falls cause a reduction in mobility in these population. The effect of a tailored exercise program for the elderly living in geriatric homes in an Indian setup are least studied.

Methods: Participants were selected from 4 different geriatric homes in India. A total of 163 individuals, 60 to 95 of age, were divided into 2 groups. The experimental group received a structured supervised exercise program for 5 days followed by home based program at their geriatric homes. Both groups received awareness regarding falls and its prevention. The primary outcome measure was the number of falls and the secondary measures included Long Term Care Fall Risk Assessment (LTCFRA), Berg Balance Scale (BBS) and Dynamic Gait Index (DGI). Outcome measures were assessed prior to the study and after 3 months of follow up.

Results: The study identified a mean reduction of 0.45±1.15 and 0.15±1.01 in the number of falls in experimental and control groups respectively. There was a significant improvement in BBS and DGI scores in the experimental group (p=0.000) but the control group failed to show an improvement. There was a significant increase in LTCFRA tool in control group showing an increase in the risk factors of fall.

Conclusion: Early intervention with structured exercise program in elderly individuals may reduce incidence of falls and factors associated with risk of falls. This may reduce the fear of falls and also the financial and physical burden of caregivers arising out of co-morbidities of falls.

1. INTRODUCTION

In the present era, concerns regarding the geriatric population are given most priority. It is estimated that 7.7% of the Indian population are of above 60 years of age, with a total of approximately 76.6 million.[1] The mean life expectancy of elderly are predicted to increase in the coming years due to improvements in healthcare infrastructure across the world. As the age advances, majority of the systems in our

body undergo modifications that lead to decline in their structural and functional integrity. Older age is susceptible for communicable and non-communicable diseases. Common disorders include arthritis, heart diseases, diabetes, hypertension, and cancer.[2] Natural decline in body functions and presence of co-morbidities, make the elderly population vulnerable for falls. Fall is one of the serious health issue for the elderly population, because it can lead to physical disability, dependency and at times, death. WHO statistics identified a total of 646,000 fatal falls per year making it the second leading cause of unintentional injury and death, next to road traffic accidents.[3] It is a major factor causing physical and financial burden within the family.

There are multiple internal and external risk factors involved in causing fall. These factors can be classified as biological, behavioural, environmental, and socioeconomic factors.[4] Biological factors can be age, sex, race, and age related decline of physical and cognitive functions and presence of chronic illnesses like Parkinson disease. Behavioural factors include human actions, emotions and daily choices like excessive medications, alcohol intake, and etc. Environmental factors such as hazardous home environment like poor lighting, narrow passages, narrow steps, slippery surfaces, and etc., play interactive role to cause fall. Socioeconomic factors include low income, low education, inadequate housing, lack of social interaction, limited access to health and social care especially in remote areas, and lack of community resources. The psychological consequence of falls include increased fear of fall and cause subsequent reduction in mobility levels. In people who fall approximately, 36% of people develop a fear due to fall.[5] Such reductions initiate a vicious cycle of activity limitation and raise in impairments.

Geriatric homes are elderly care homes/long term care homes which are run by government, non-government organisations and private organisations in India. The inmates of these homes are those destitute elders who are abandoned or neglected by their families, living alone and in greater difficulties and suffering from bodily illness for which they are unable to take care themselves, and those who willing get admitted to these facilities for better living conditions.[6] Approximately 30-50% of people living in long-term care institutions fall each year, and 40% of them experienced recurrent fall.[7] Consequently, it leads to a decline in functional ability and overall quality of life.[8] Therefore, preventing falls among the elderly and rehabilitating them becomes essential to maintain their level of independence in activities of daily living and to improve overall the quality of life.

It has been found that the fall percentage is more among the elderly population living in long term care institutions than the people living in community.[7] The effectiveness of interventional programs are found to be insufficient due to presence of complex multiple problem among the elderly population living in the long term care homes.[9] Comprehensive therapeutic strategy need to be developed to address this issue. Hence, the study aimed to find the effect of a multi component home based training program at their geriatric homes on falls prevention and its effect on balance, and gait parameters in elderly population living in long term care homes.

2. METHODS

The study was conducted at 4 different geriatric homes in Nagpur district of Maharashtra and Bangalore district of Karnataka in India for a period of 2 year. A total of 163 elderly individuals were recruited for the study. The inclusion criteria of the study were: 1). elderly individuals aged 60 years and above; 2). both male and female staying at geriatric homes; 3). individuals who are willing to participate in the study and providing signed informed consent form; 4). Mini Mental Status Examination (MMSE) scores more than 18; 5). individuals who are able to move indoors with or without walking aids; and 6). individuals who are not receiving any prior physiotherapy sessions to improve ambulatory efficiency. Individuals having severe orthopaedic, neurologic or cardiopulmonary conditions in whom independent ambulation was not possible with or without aids were excluded from the study.

The consort diagram on the study is depicted in Figure 1. Participants were randomly divided into two groups using computer generated random number tables, into experimental and control group. Experimental group received home based exercise program at their geriatric homes for three months. Exercises were taught on the first day, and patients received supervised exercise program for the first week. Later on, the therapist visited the participant once in every 15 days for 3 months. Each session last for 30 minutes, once per day. Participants in the experimental group were also advised to walk outside the home for 30 minutes in a day. Safety was ensured by prescribing each exercises appropriately, by giving the subject adequate instructions on each exercises. The structured exercise program prescribed to the participants in the experimental group are provided in Table 1. The control group received an educational program at the beginning of the study regarding awareness and prevention of falls, which included identifying the risk factors of falls, identifying and avoiding environmental hazards, maintain the habit of walking daily at least for 15 minutes, identifying orthostatic hypotension due to sudden changes in position, and understanding the need of consultation with a doctor to alter the medications. The experimental group were also provided with the

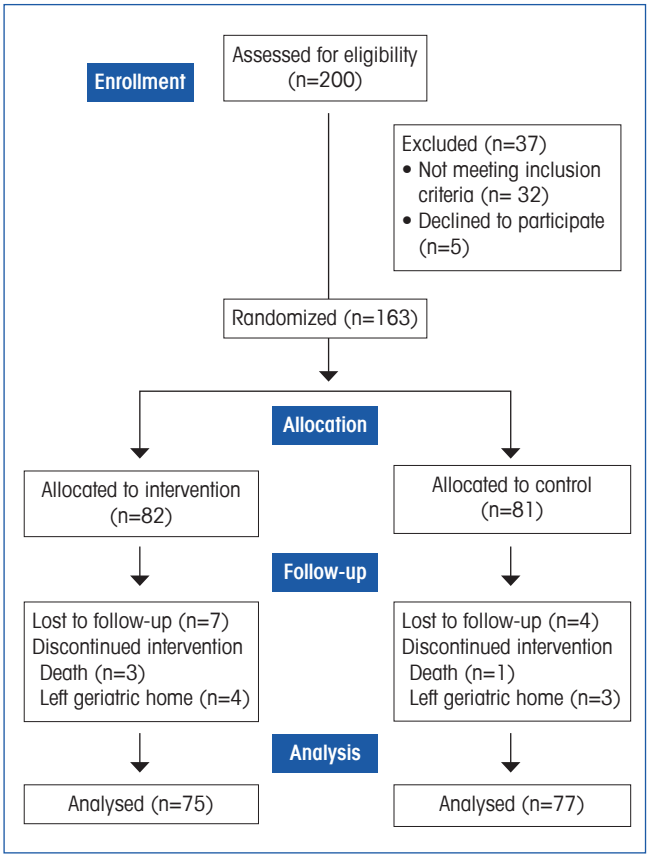
same educational program at the beginning of the study. Researcher didn't interfere in any of the daily routine activities of the participants.

A predesigned data collection form was used to collect information from all participants. Socio-demographic details such as age, height, weight, income, educational qualification, and marital status, and medical history were recorded. The study had one primary outcome and three secondary outcomes. Primary outcome measure was the number of falls occurred to the patient. Subjects were asked to recall the number of falls during the three months preceding the entry into the study. "History of Fall Questionnaire" was used to document the incidence of falls occurred during the 3 months prior to the study. In subjects with multiple falls, each fall was documented separately. The secondary outcome measures were Long Term Care Fall Risk Assessment (LTCFRA),[10] Berg Balance Scale (BBS),[11] and Dynamic Gait Index (DGI).[12] Pre-test measurements were assessed on the first day of recruitment to the study.

Monitoring for falls began on the first day after recruitment to the study. A falls diary was maintained separately for all individuals by the researcher to record the incidence of falls during the study period. Fall, injuries from falls and compliance for exercise program was monitored during this period. Post-test assessment of primary and secondary outcome measures were assessed after 3 months of the recruitment to the study.

LTCFRA consists of eight parameters:[10] mental status, history of falls, ambulation/elimination status, vision status, gait/balance/ambulation, systolic blood pressure, medications, and predisposing diseases. A score <10 represents low-risk of fall whereas score above 10 represents high-risk. BBS objectively determines the ability of the individual to safely balance during a series of 14 predetermined tasks. Each task consist of five-point ordinal scale ranging from 0 to 4, scored according to the performance. The maximum score available is 56, whereas a score less than 45 indicates a greater risk of fall for the individual under consideration. Neuls, et al., suggests the usefulness of BBS in conjunct with other assessment tools in assessing the fall risk in elderly population.[11] DGI is a clinical tool used to assess gait, balance and fall risk using 8 functional walking tests. Each tests consists of a four-point ordinal scale ranging from 0 to 3, 0 being the lowest level of function. The total score is 24, and a less than 19 is predictive of falls in the elderly.[12]

Figure 1. Study consort diagram.



2.1. Statistical Analysis

Data was analysed using IBM SPSS statistics version 20.0 (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY). Descriptive statistics used were frequencies, mean and standard deviation. Paired *t* test was used to identify the significance between the pre-test and post-test scores

Table 1. Exercise protocol prescribed to patients in the experimental group.

Type	Segment	Repetition	Progression
Bilateral ROM Exercises	Shoulder, elbow, wrist, fingers, hip, knee, ankle, and trunk (rotation and side bending) (active)	10 reps, once daily	Nil
Bilateral Stretching Exercises	Upper thoracic muscles, triceps, quadriceps, glutei, hamstrings, and gastrox (active)	5 sec hold, 3 reps, once daily	Nil
Bilateral Strengthening Exercises	Hip extensors and abductors, knee flexors and extensors, ankle plantar and dorsiflexors	20% of 1RM, 10 reps x 3 sets, once daily	Gradually progress up to of 80% 1RM
Balance Exercises	Tandem standing, tandem walking, toe & heel walking, walking backwards & sideways	2 min each, once daily	Increase 1 min every 2 weeks
	Obstacle clearance, picking up objects from floor, Sit to stand, and half squats	10 reps, once daily	Increase 5 reps every 2 weeks
	Climbing stairs	1 flight, 3 reps	Increase 1 flight every 1 month

of the outcome measures of experimental and control groups. The *p* value less than 0.05 was considered significant. Chi square test was performed to compare the incidence of falls between groups by category.

3. RESULTS

Out of 163 elderly individuals, 76 males (46.6%) and 87 females (53.3%) were included. The age of the participants ranged from 60-95 years (mean=74.6±8.5). The experimental and control group had 82 and 81 participants respectively. The comparison of anthropometric measures between the 2 groups are shown in Table 2. There was a significant statistical difference in the body mass index (BMI) between males and females but no significant difference was observed for age.

The experimental group consisted of 37 men (45.1%) and 45 (54.9%) women, where as in control group, 39 (48.1%) were men and 42 (51.9%) were women. According to the MMSE assessment, mild cognitive impairment (MMSE ranging from 19-23) was found in 22 (28.9%) men and 39 (44.9%) women which did not interfere the study. The mean MMSE scores for men were 23.5±4.3 and women were 22.5±5.0 (*t*=1.3, *p*=0.166).

Prior to study, 116 subjects (71.1%) did not have any history of falls, and 47 subjects (28.9%) had at least one fall. It was noteworthy that women had more episodes of fall than men. Out of the 47 fallers, 13 men (27.6%) had 24 falls during the previous 3 months of study, whereas 34 women (72.3%) had 81 falls, bringing a total of 105 fall episodes. Pre-test assessment of primary outcome revealed a total of 60 falls in experimental group and 45 in control group (*t*=0.7, *p*=0.487). The gender-wise distribution in groups, and on MMSE and history of falls according to the baseline values are illustrated in Table 3.

Out of 163 participants, there was a dropout of 11 participants (6.7%) from the study, 7 from experimental and 4 from control group. The reasons for loss of follow-up included death (n=4) and left the geriatric homes (n=7). Thus the post-test analysis was done for 75 subjects in experimental group and 77 in control group.

During the 3 months of the study, 14 participants (18.7%) in the experimental group and 20 (26%) in the control group had at least one fall (χ^2=1.1, *p*=0.332). Number of falls measured during the post-test assessment in the experimental group was 26, whereas in the control group was 37 (*t*=1.4, *p*=0.176). The mean reduction in number of falls between the pre- and post-test scores in the experimental group was 0.5±1.2 and in control group was 0.2±1.1 (*t*=1.9, *p*=0.048) (Table 4).

The comparison of secondary outcome measures between experimental and control group is depicted in Table 5. Homogeneity was maintained prior to the study between the groups as assessed by *t* test for all the outcome measures. It was identified that there is a reduction in scores of LTCFRA in the experimental group (mean difference [MD]=-0.5±1.3), whereas control group had an increase in scores (MD=+0.4±1.4) while comparing the pre- and post-test scores. BBS scores showed an increase in the experimental

Table 2. Descriptive details between the groups.

Characteristics	Experimental Group	Control Group	*t* Test	*p* Value
	Mean±SD			
Age	75.3±8.7	73.9±8.3	1.003	0.317
Height	153±10.5	153.3±10.2	0.182	0.856
Weight	53.1±10.8	54.1±12	0.581	0.562

Table 3. Gender-wise distribution of groups, MMSE, and history of falls.

Characteristics	n	Men	Women
Total participants	163	76	87
Participants in experimental group	82	37	45
Participants in control group	81	39	42
MMSE (mean)		23.5±4.3	22.5±5.0
MMSE <19	61	22	39
Number of fallers 3 months prior to study	47	13	34
Total number of falls	105	24	81

Table 4. Pre- and post-test analysis of primary outcome measure.

Scores	n	No Falls Recorded (n)	At Least 1 Fall (n)	Experimental Group	Control Group	Significance
Pre-test	163	116	47	N=26 Total falls[#]=60 Mean*=0.8±1.4	N=21 Total falls[#]=45 Mean*=0.7±1.3	*t*=0.696 *p*=0.487
Post-test	152[$]	118	34	N=14 Total falls[#]=26 Mean*=0.3±0.8	N=20 Total falls[#]=37 Mean*=0.5±1.1	*t*=1.351 *p*=0.176
Mean reduction between pre- and post				0.5±1.2	0.2±1.1	*t*=1.999 *p*=0.048

[#]Total number of fall incidence occurred in the group. *Mean number of falls per person. [$]11 participants were lost for follow up, 7 from experimental and 4 from control group.

Table 5. Pre- and post-test analysis of secondary outcome measures.

Outcome Measure	Group	Pre-Test	Post-Test	*t* Value*	*p* Value
Long Term Care Fall Risk Assessment	Experimental	8.1±5.3	7.6±4.6	0.595	0.552
	Control	7.1±4.9	7.5±5.2	0.455	0.000
Berg Balance Scale	Experimental	46.7±10.3	47.0±9.9	0.582	0.000
	Control	47.7±8.8	44.7±9.9	1.980	0.05
Dynamic Gait Index	Experimental	18.1±6.1	18.8±5.9	0.737	0.000
	Control	18.5±6.4	17.3±6.7	1.154	0.25

*Paired *t* test done to compare the pre and post mean values.

group (MD=+0.9±1.8) whereas the control group demonstrated a reduction in scores (MD=-2.9±3.6). DGI scores also demonstrated an increase in experimental group (MD=+0.7±1.0) and decrease in control group (MD=-1.2±1.9). Therefore, there is a significant effect of the exercises prescribed to the experimental group in reducing fall risk as well as episodes of fall.

4. DISCUSSION

In our study, there was a significant reduction of falls in the individuals who were part of experimental group than that of control group. The total episode of falls prior to the study was 105, which was reduced to 63 episodes with the individuals. It is thus been identified that the predesigned exercise program comprising of ROM, strengthening and balance exercises has a significant effect on reducing falls in elderly individuals. There is a lack of evidence supporting the effect of exercise programs over the physical function in the elderly individuals in nursing or geriatric homes.[13-15] Our study contributed to this gap by identifying the effect of structured exercise program in elderly individuals staying at various geriatric homes in India.

The study identified an overall reduction in the risk of falls in individuals to underwent structured exercise program (MD=-0.5±1.3), whereas we identified that those who were not provided with any of the supervised training had an increase in risk of falls after the study period (MD=+0.4±1.4). Our study also supports the hypothesis that exercises have a positive impact on improving the balance and gait parameters of elderly individuals. There was a mean increase in scores of BBS (MD=+0.9±1.8) and DGI (MD=+0.7±1.0) post intervention in participants in the experimental group, which were statistically significant, demonstrates a net increase in scores. The control group in fact had a reduction in both BBS and DGI scores during the 3 months follow up. Thus the study identified a need of early administration of tailored exercise program to elderly individuals to maintain their balance and gait parameters and thus to prevent the deterioration of the condition which can predispose to falls. Training balance and gait has a positive influence in reducing risk of falls and to avoid fear of fall in these population.

Various studies support the effect of structured exercise program in the management of falls and improvement in physical function of the elderly. Sauvage LR, et al., identified that moderate to high intensity strengthening and endurance exercise program for 12 weeks will significantly improve the gait and balance in elderly.[16] Weerdesteyn V, et al., had designed a Nijmegen Falls Prevention Program which includes balance, gait and coordination training in an obstacle course which mimics activities of daily life with potential risk of fall. This tailored exercise program found to reduce falls, and improvement in balance confidence and obstacle clearance.[17] Multi-component exercise program focusing primarily on strength and balance training found to be the most effective strategy in the management of falls in the elderly.[13,18] Clemson L, et al., have demonstrated a 31% reduction in fall rates through balance and strength training.[19] Strength and balance training in elderly individuals are successful in reducing the episodes of falls. The muscles around the ankle joint are considered to be important for recovery of balance.[20] A near normal range of motion of ankle joint seems to be necessary for utilizing better balance strategies and to maintain steady posture during perturbations.[21] Thus a need of a strength and flexibility training is enforced in the planning of a structured exercise program in elderly individuals.

Strength and balance training found to have positive effect on gait stability, well-being and mobility.[22-24] The meta analysis by Sherrington C, et al., identified a pool estimate of 17% reduction in falls by exercise.[25] They conclude that higher dose of balance training must be given more priority within the various component of the structured exercise program.

Falls in the elderly possess a serious threat to this population worldwide. The previous study conducted by us revealed the factors leading to falls which includes poor vision, chronic conditions, vertigo, imbalance, fear of fall, and episodes of previous fall.[26] Fall can be considered as a multi-factorial condition which are often neglected to manage because the clinicians are more experienced in managing discrete conditions. Most falls occur during the periods of

maximum activity.[26] Therefore the fear of fall within an individual will influence his activities leading to restriction in participation in the peer groups. This can even divert our focus to a psychological approach in the management and prevention of falls. Medical professionals must implement programs focussed on fall prevention by weighing its risk and benefits in implementing the same. The goal of medical management must be to maximize overall health and functional benefits of medications and minimizing their adverse effects.[27]

In conclusion, we suggest that a well-designed tailored exercise program is advisable for the elderly individuals to improve the gait and balance function and thus may reduce the episodes of fall and the risk of falls. Implementing exercise regimen as earliest is important to improve the quality of life of these population.[24] This may also help in reducing the financial burden of the caregivers as well as promote independence in ADL without fear of fall. Thus we suggest to implement exercise programs as early as possible which may improve the physical and mental wellbeing of the elderly population living in the geriatric homes by reducing incidence of falls.

Our study identify better compliance towards the exercise program by the elderly population. The attrition rate of our study was 6.7% (n=11) out of which 4 were expired. The individuals enjoyed participating in the exercise program and didn't complain about any untoward incidents. The limitation of the study includes a lesser contact time of the individuals in the control group with the researcher. This may have led to bias in the results. The supervision of exercises were limited to only 5 days after which individuals performed themselves. Future studies can be considered having a larger population and longer follow up periods. Further studies consisting of a structured institutional based supervised exercise program with equipment assisted assessment protocols will give a better picture of the current study.

CONFLICTS OF INTEREST STATEMENT

Authors declare no conflict of interest. Authors received no financial support/grant for this study. Authors have no financial interests related to the material in the manuscript.

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