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Original Research Article

Impact of Group Exercise Programme on Fall Risk in Elderly Individuals: A Pilot Study

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ABSTRACT

Background: Around 30% of elderly people over 60 years of age experience a fall each year. The frequency of falls increases with age and frailty level. Therapeutic exercise plays restorative and accommodative role in minimizing loss of stability in the elderly through balance and mobility improvement hence reducing fall risk. This study was aimed to determine the impact of a supervised group exercise programme on fall risk and its modifiable risk factors.
Methods: The pilot randomized controlled trial included 45 elderly individuals over 60 years of age and having increased fall risk. Eligible participants were assigned to group exercise programme or individualized exercise programme. Demographic data, Timed Up and Go test, 5-times sit to stand test, sway index and dynamic postural stability, were assessed before and after 10 weeks of intervention.
Result: Both groups improved in all the outcomes, as shown by the significant intra-group differences in pre- and post-intervention comparisons ($p<0.005$).There was no significant difference between the experimental and the control groups after the completion of intervention ($p>0.005$).
Conclusion: Group exercise programme had a positive impact on elderly individuals as it was effective in reducing the fall risk, improving the balance and lower extremity strength after the intervention.

Keywords: fall risk, group exercise programme, balance, strength

INTRODUCTION

A fall is defined as "an event which results in the person coming to rest inadvertently on the ground or other lower level not as a result of a major intrinsic event or overwhelming hazard. [1]

Falls in elderly population are one of the most frequent and serious problems and are the leading cause of injury in this age group. Around 30% of generally healthy elderly people over 60 years of age experience a fall each year, and around half of them will have repeated falls. [2-4] The frequency of falls increases with age and frailty level, and the incidence varies across countries. Previous researches stated that, the incidence in China was 6-31% while in Japan, 20% of older adults fell each year. A

study in the Region of the Americas found the proportion of older adults who fell each year was 21.6% in Barbados to 34% in Chile [5] whereas in India, the reported prevalence ranged from 14% to 53%. [6]

A fall can cause physical and psychological consequences that subsequently reduce the quality of life. [2] Consequences of falls include soft tissue injury, fracture, pain, impaired function, decreased confidence in carrying out activities of daily living, loss of independence and autonomy, and sometimes even death. [7-9] Elderly individuals, who fall, with or without sustained injury, may develop a fear of falling. Falls and fear of falling are having bidirectional relationship. [10]

Risk factors for falls in elderly are multifactorial and complex, comprising of intrinsic factors, including the physiological changes of ageing, frailty and pathologies, as well as extrinsic, environmental and situational factors. [11] However reduced strength and poor balance are considered the most readily modifiable risk factors for falls and can be improved by specific exercises. Balance is a complex motor skill that describes the dynamics of body posture in preventing fall. Loss of balance is associated with aging, and the age related decrease in muscle mass decreases muscle function aggravating the fall risk. Physical therapy intervention plays restorative and accommodative role in minimizing balance instability and hence decreasing risk of fall. [12,13]

Falls are an independent predictor for long-term hospitalization. The economic burden of falls increase with fall frequency so prevention or reduction of falls and fall-related injuries would be a significant contribution to the health and well-being of elderly persons and could potentially result in reduced health care costs. [8,9]

Researches provides justification for use of therapeutic exercise which plays restorative and accommodative role in minimizing loss of stability in the elderly through balance and mobility improvement hence reducing fall risk. [9,14] The Otago Exercise Programme (OEP) is a well-designed and tested falls prevention programme that targets strength and balance deficits and can lead to a reduction in falls by about one-third. [3,15,16] It is not known whether implementing the programme in a group setting will be effective in reducing falls and subsequent injuries by achieving the required gains in strength and balance. [15] Despite the large body of existing literature in this field, reevaluations of those apparently effective strategies in modes are still warranted.

Community-based group exercise programmes that are easily accessible, affordable and held at times and frequencies suitable for older people may meet these needs. [17] Various reasons were put forward for group exercising like putting the responsibility of exercise on participants, using their competitive spirit in a healthy manner. According to Campbell, Mutrie group exercises have positive impact on psychological function. [18] In group exercises, working with other participants stimulates individual's efforts and confidence in the own abilities while the performance is guided and controlled by the physiotherapist. [19] However, there is inadequate evidence to date to determine whether group exercise targeted to at-risk elderly individuals is effective in preventing falls. [17]

Hence this study aimed to determine the impact of a supervised group exercise programme, on balance and functional variables representing the performance skills connected to the fall risk, compared to the same regimen applied individually. The objectives of the current study were to find out the effect of a group exercise programme on clinically applicable functional tests i.e. timed up and go test for assessing fall risk [20] and 5 times sit to stand test for lower limb strength [21] as well as on instrument assisted balance testing in terms of modified-Clinical Test of Sensory Integration of Balance and limits of

stability. [22] Also fear of fall was assessed with Falls Efficacy Scale- International. [23]

MATERIALS AND METHODS

- The present study received approval from the Ethics Committee of Pravara Institute of Medical Sciences India in collaboration with the School of Health and Welfare, Technological educational Institute of Western Greece. Participants were screened based on the inclusion and exclusion criteria described below. Those individuals who were willing to participate were briefed about the study with a detailed information sheet and a written informed consent was obtained. Audiovisual consent was also taken from all the individuals participated in the study.
- **Study setting:** The experimental intervention protocols were implemented in 3 Municipality's elderly care centers of Patras under the guidance and supervision of Physiotherapy department of Technological Educational Institute of Western Greece. Functional and instrument based pre and post intervention assessment of participants took place in the Rehabilitation Clinic of Spinal cord Injuries of University of Patras.
- The Study was a pilot randomized Controlled Trial. Fifty one community dwelling elderly volunteers satisfying the following inclusion criteria were enrolled in the study: males and females with age:>60 years, increased fall risk assessed by timed up and go test[TUG score >10 seconds] and fear of fall [FES score > 19],significant concern about their balance, not involved in regular exercise programme and willing to participate. Participants excluded were those with a history of traumatic fall within past year, uncontrolled cardiovascular disease, severe cognitive impairments, physical deterioration due to severity of associated comorbidity, neurological disorders, severe depression, undergoing palliative care, those with amputation and having prosthetic limb.
- Eligible participants were assigned an experimental group or a control group by permuted block randomization, and were then scheduled for baseline assessments. Demographic data (Table 1), TUG, 5-times sit to stand test, m-CTSIB, LOS, were assessed before and after 10 weeks of intervention.
- **Detailed intervention protocol:**
- The intervention consisted of exercises pertaining to warm up, balance retraining exercises and lower limb strengthening exercises derived from OEP for 2 times in a week for 10 weeks. Duration of each session were from 30 minutes initially then progressing to 60 minutes. The intervention protocol was implemented to the experimental group consisting of 6 participants in each group and the same protocol was implemented to the control group individually i.e. one participant at a time.
- **Intervention received by both the groups is as follows:**

Warm up: Spot marching, mild stretching of large muscles groups: stretching of cervical flexors, extensors, side flexors, rotators, shoulder flexors, extensors, pectoral muscles, hamstrings, quadriceps, quadratus lumborum, muscles.

Strengthening exercises: Exercises derived from OEP were given using elastic resistance bands varying from low resistance to high resistance. Intensity of exercises was defined by level of difficulty, fatigue and number of repetitions starting from 12-13 RPE (somewhat hard) and progressing to 14-16 RPE (hard) with 10 - 15 repetitions (moderate resistance until muscle fatigue) and then 8-12 (high resistance until muscle fatigue). Initially 1 set progressing to 2, 3 sets of exercises with 2 minutes rest between sets. [24] Target muscle groups were hip extensors and abductors, knee flexors and extensors, inner range quadriceps and ankle plantar and dorsiflexors. [12]

Balance retraining exercises: Certain exercises derived from OEP were given comprising of sit to stand and knee squats starting from 10 repetitions with support then progressing to 3 sets of 10 repetitions without support, tandem stance, single limb standing with support and eyes open and progressing to eyes closed for 10 seconds without support, tandem standing to tandem walking; Walking backwards, sideways walking, walking and turning around 10 steps 4 times with support then 10 steps 4 times without support. [15]

Outcome measures:

The pre-post intervention assessment of participants was done by 2 functional tests and 2 balance parameters from Biodex Balance System $_{SD}$®

- Timed Up and Go test for assessing the fall risk and functional performance. The TUG is a timed performance of getting up from a chair, walking 3 m, turning around, and walking back to sit down again A faster time indicates a better functional performance and a score of ≥13.5 seconds is used as a cut-point to identify those at increased fall risk in the community setting. However, reported threshold values vary from 10 to 33 seconds in the literature. The cutoff point used in this study is 10 seconds based on the previous research findings. [20] Excellent inter-rater and intra-rater reliability has been established for use of the TUG in community dwelling elderly population. [24,25]
- 5- times sit to stand test [Chair-stand test] for assessment of lower limb strength simple chair stand test, which may identify lower-extremity weakness, poor muscle power, and limitations in dynamic balance, may be sufficient for evaluating performance as part of a risk stratification strategy for injurious falls. [26,27]
- m-CTSIB i.e. modified Clinical Test of Sensory Integration of Balance on Biodex balance system$_{SD}$®. This is a standardized test for balance assessment by quantifying sway index and effective for identifying individuals with mild to severe balance problems and provides a generalized assessment of how well a patient can integrate various senses with respect to balance and compensate for sensory dysfunction. The m-CTSIB protocol consists of four separate conditions, of increasing difficulty, performed with the subject in a quiet upright stance. They are 1) firm surface with eyes open, 2) firm surface with eyes closed, 3) foam surface with eyes open and 4) foam surface with eyes closed. Each sub-test lasts 30 seconds and is repeated 3times. [28]
- Limits of stability (LOS) test is a good indicator of dynamic control within a normalized sway envelope and challenges patients to move and control their center of gravity within their base of support on Biodex balance system$_{SD}$®. It analyzes a subject's ability to voluntarily move their center of gravity to the limits of stability in the eight cardinal and diagonal directions. Higher values depict improved stability. It has good to excellent reliability [28,29]
- The Falls Efficacy Scale International (FES-I), is a self-report questionnaire developed and validated by the Prevention of Falls Network Europe (ProFaNE), has become a widely accepted tool for assessing fear of falling for a range of activities of daily living FES-I had excellent internal and test–retest reliability (Cronbach'sα=0.96, ICC=0.96). [30,31]

Statistical analysis:

All variables were tested for normality of the distribution via the Shapiro-Wilk test and were treated accordingly. In specific the "FES" and "TUG" variables were not normally distributed and were treated as non-parametric, while the "5- times sit to stand test", the "m-CTSIB" and the "LOS" variables displayed close approximation to

symmetry and were treated as parametric variables.

The analysis included a) comparisons of dependent variables between pre and post intervention values, to test whether the intervention produced significant results and b) comparisons for independent variables, between the two groups, to test the possibility of either type of intervention being more efficient.

The SPSS v.20 was used for the analysis and the probability level was set to α=0.05.For the normally distributed variables, the paired student t-test was used for the within group pre-post comparisons and the unpaired student t-test was used for between groups comparisons. For the non-parametric variables, the Wilcoxon signed rank test was used for the within group pre-post comparisons and the Independent-Samples Mann-Whitney U test was used for between groups comparisons.

RESULTS

Total 51 elderly individuals participated in this study out of them, 1 participant from experimental and 5 from control group dropped out of the study. From experimental group 1 participant did not complete the intervention because of scheduling conflicts and access problem and 3 participants from control group discontinued as they lost interest and 2 of them had family issues. The present study included 45 elderly individuals with a mean age (SD) of 73.5 ± 4.94 years. Both groups were similar at baseline as shown in table 1 and 2[p>0.005]. From experimental group 19participants were fully adherent whereas 4 participants missed 1 session. In control group 15 completed all the sessions and 7 missed 1 session. No adverse event was noted during the study period.

Table 1: Baseline comparison of demographics and parametric variables:

Variables	Experimental group (n=24)mean±sd	Control group (n=21)mean±sd	p
Age	69.5 ± 5	69.4 ± 5.4	>0.005
BMI	26.2 ± 1.2	26.1 ± 1.3	>0.005
TUG	13.4± 1.4	13.8 ± 1	>0.005
FES	33.4 ± 11.8	30.7 ± 9.3	>0.005
5TSTST	22.6 ± 6.4	20.9± 4.6	>0.005
mCTSIB	1.7 ±0.3	1.8 ± 0.3	>0.005
LOS	41.3 ±10.6	40 ±13.8	>0.005

Table 2: Baseline comparison of non-parametric variables:

Variables	Experimental group (median and range)		Control group (median and range)		p
TUG	13.50	9.40-16.70	13.70	11.90-15.60	>0.005
FES	30.5	20-59	27	20-46	>0.005

Specifically, the Shapiro-Wilk statistic= .887 and .815for the FES pre and FES post scores of the experimental group was significant (p= .020, p= .001 respectively).The Control group displayed no normally distributed curves in the FES pre-post and TUG pre-post (Shapiro-Wilk statistic= 0.864, 0 .747 and 0.902, respectively, with p values= .004, .000 and .024).Hence, the "FES" and "TUG" variables were not normally distributed and this was additionally verified by observation of the Q-Q plots. For both variables, non-parametric tests were used, namely the Wilcoxon signed rank test was used for the within group pre-post comparisons and the Independent-Samples Mann-Whitney U test.

Both groups improved in all the outcomes, as shown by the significant within group differences in pre- and post-intervention comparisons, whilst, there was no significant difference between the experimental and the control groups after the completion of intervention.

The within group comparison for parametric variables of both groups by paired t-test appear in tables 3, 4 respectively. Lower limb strength was assessed by the 5 TSTST. Table 3,4 shows the significant changes in 5TSTST results for participants in both groups. Balance was assessed in terms of m-CTSIB and LOS on Biodex balance system[SD]. It was observed that scores of m-CTSIB and LOS in control

group and experimental group were statistically significant after the intervention (table 3,4). For 5TSTST, m-CTSIB improvement is indicated by decreased score whereas for LOS improvement is indicated by increased score.

Table 3: Experimental group: Within group comparison of parametric variables:

Variables*	Mean	t	df	Sig. (2-tailed)
5TSTSTpre	22.6±6.4	11,04	23	0.000
5TSTSTpost	10.6±2.2			
m-CTSIB pre	1.70±0.3	5,981	23	0.000
m-CTSIB post	1.28±0.3			
LOS pre	41.3±10.6	-4,259	23	0.000
LOS post	53 ±11.7			

Table 4: Control group: Within group comparison of parametric variables:

Variables*	Mean	t	df	Sig. (2-tailed)
5TSTST pre	20.9 ±4.6	9,825	20	0.000
5 TSTST post	10.7±2.1			
m-CTSIB pre	1.85±0.3	5,145	20	0.000
m-CTSIB post	1.40±0.3			
LOS pre	40.0±13.8	5,090	20	0.000
LOS post	52.1±16.6			

Within group comparison of non-parametric variables by in Wilcoxon signed rank test in both groups revealed that, participation in 10 weeks intervention was associated with reduction in fear of fall as well as fall risk (Tables 5,6).

Table 5: Experimental group: Within group comparison of non parametric variables:

Variables	Median	Range	Sig.
FES pre	30.5	20-59	p=.000
FES post	19.5	16-45	
TUGpre	13.50	9.40-16.70	p=.000
TUGpost	7.25	4.65-11.80	

Table 6: Control group: Within group comparison of non parametric variables:

Variables	Median	Range	Sig.
FES pre	27	20-46	p=.000
FES post	18	16-35	
TUGpre	13.70	11.90-15.60	p=.000
TUGpost	8.20	5.70-11.50	

The between groups post-intervention comparisons, proved to be non-significant by unpaired student t test, in all cases for the parametric variables of 5STST, m-CTSIB and LOS (Table 7). All p-values are considerably higher than the limit set for rejecting the null hypothesis.

Table 7: Between group comparison of the parametric variables:

Variables	Control group	Experimental group	t	P value
TSTST post	10.7 ±2.1	10.6 ±2.4	.126	>0.005
Mctsib post	1.4± 0.3	1.2 ±0.3	1.243	>0.005
LOS post	52.1 ±16.6	53 ±1.7	-.191	>0.005

Between group post intervention comparisons for the non-parametric variables of FES and TUG, showed no statistical difference by the Independent Samples Mann-Whitney U Test. For the post intervention comparisons, gave p=.152, whereas the TUG post intervention p=.111.9 (>0.005)

DISCUSSION

The present study determined the impact of a supervised group exercise programme on fall risk in elderly individuals. This was an important question to be answered, since it will be valuable in terms of cost effectiveness for the community to know whether the application of exercise for in the elderly in small groups, are equally efficient as individualized interventions in minimizing fall risk.

This study demonstrated that a supervised group exercise program and individualized exercise programme consisting of strengthening and balance re training exercises, were safe and associated with reduction in fall risk and fear of fall, as indicated by TUG and FES respectively, as well as an improvement balance in terms of sway index and dynamic control and lower extremity strength, as indicated by 5TSTS.These results are consistent with findings from a previous researches which stated that integration of balance and strength training into daily life activity reduces rate of falls and maintains optimal functional level in older people. [32,33] This study also reported reduced FOF which is in line with a study involved balance training in a geriatric setting and achieved a 3% decrease in fear of falling measured using the Falls Efficacy Scale International questionnaire [34] n another study, a program of Taichi exercises induced an 11%

reduction in fear of falling as measured by the Activities-Specific Balance Confidence Scale questionnaire. [35]

Improvement in balance was an important outcome in participants of both the groups. Studies have confirmed that impaired balance is a stronger risk factor for falls [36] and further stated that exercise improves balance and mobility and prevents falls among senior citizens. [37] This study concluded that OEP as a home based exercise can improve functional capacity, as a good predictor for balance and can increase physical performance. Another study supporting this result involved a structured LiFE programme which improved both static and dynamic balance, The importance of balance exercises in mediating fall risk, was highlighted in a systematic review which examined 44 exercise trials in terms of fall outcome and exercise intensity. The functional activities in the LiFE programme showed steady improvements, all programmes made variable gains for knee and hip strength. [32]

In the present study, lower extremity strength improvement was shown by both the groups after intervention. This finding might be due to the specificity principle of exercise training. [38] Researches have stated that fall risk increases with aging because a decrease muscle mass, which decreases muscle function. Numerous studies provide encouraging evidence that older muscles adapt vigorously to resistance training with increased motor activation and myofibre hypertrophy also increases muscle mass, strength and power, reduces the difficulty of daily tasks, enhances energy expenditure and body composition, and promotes participation in spontaneous physical activity. [39] Another study reported that improvement in the strength of the lower extremities enhances the balance of the elderly. [40] In addition to this researchers reported, strengthening exercises using elastic resistance are practical because they have only a small risk of injury, provide consistent tension, and are easily portable and inexpensive. Elastic-resistance exercises help not only in rehabilitation but also in other areas because they have been proven to improve muscle strength and stability. So they concluded that the balance exercises and elastic-resistance exercises conducted for 8 weeks improved leg muscle strength and proprioception of the neuromuscular system through muscle contraction and stimulation of proprioceptive sense. [12]

In the current study, experimental group had a tendency for additional benefits like more adherence, cost effectiveness and social support as compared to individualized exercise programme. There are several possible explanations for varying results. Group exercise led to encouragement and stimulation, participants knew they were working towards a common goal and so were helping each other attain that goal which led to more adherence. Participants learned to work with others and increases social interaction, gained confidence to hold his responsibility when group members perform exercises in union. [41] This finding was supported by the study of Barnett et al, who stated that group exercise programmes are easily accessible and affordable. [17]

Individual therapy allows the client to receive intensive, focused attention and to discuss difficult issues in a private setting. [41] Hence this group showed significant improvement in all the outcomes after 10 weeks of intervention however the adherence was lesser compared to group exercise programme which might be due to lack of motivation from group members and boredom as received intervention was given to one participant at a time. Exercise is an effective intervention strategy for preventing falls in older adults. Studies have shown that injuries, because of a fall, are reduced after the implementation of an exercise programme. [42]

CONCLUSION

Group exercise programme had a positive impact on elderly individuals as it was effective in reducing the fall risk, improving the balance and lower extremity strength after the intervention. Additionally,

there was not any difference in the outcome between Group exercise and Individualized exercise. This supports the application of fall-prevention exercise programme in small groups, which is equally efficient and more amusing and cost effective than when applied individually.

Future research in this area should involve larger samples and long term follow-up.

Clinical implications: The group exercise programme is a safe, effective, practical, feasible and low cost fall prevention intervention beneficial for elderly individuals.
Conflict of interest: None declared

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