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Original Research Article

Effects of 12 Week Group Exercise Program on Strength, Flexibility and Balance among Community Dwelling Elderly

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ABSTRACT

Purpose: To measure the effectiveness of group exercise program in elderly in terms of strength, flexibility and balance.
Methods: 15 community dwelling elderly (7 male and 8 female) were included in the study. Baseline data using senior fitness test on upper and lower extremity strength, flexibility and timed up and go test for balance were obtained. 45 minutes of group exercises were given, three times a week for 12 weeks. Post assessment was performed after 12 weeks of exercise program.
Results: One sample t-test, paired t- test and Pearson's correlation test was used for the analysis. Level of significance <0.05 was considered statistically significant with 95% confidence interval.
Upper and lower extremity strength and flexibility improved significantly in the participants post exercise program with p value 0.0001. Similarly, balance was also found to significantly improve after the exercise program (p= 0.0001).
Conclusion: Significant improvement was seen in strength, flexibility and balance after 12 weeks of group exercise program. Developing a community-based group exercise program is one means of enabling older adults to take part in physical activity and exercise.

Keywords: Elderly, strength, flexibility, balance, group exercise.

INTRODUCTION

Aging is defined as a state or condition that may or may not correlate with chronological age and more often reflects the loss of a person's capacity to maintain independence. [1] In Nepal, elderly population was 1.5 million in 2001 and 2.1 million in 2011, which constituted 6.5 % and 8.1 % of the total population in the country respectively. [2] The annual elderly population growth rate was 3.39%, higher than the annual population growth rate of 2.3%. [2]

Aging results in an exponential loss of bone and muscle, along with reduced muscular strength and power. [3] The major consequences of aging are reduce muscle strength, reduce joint flexibility and loss of balance leading to increased number of falls, [3,4] deteriorating quality of life in elderly. Approximately 25% to 35% of people over the age of 65 years experiences one or more falls each year. [5]

American college of sports and medicine has indicated that participation in a regular exercise program is an effective way

to reduce and/or prevent a number of the functional declines associated with aging. [6] Strength training will help offset the loss in muscle mass and strength typically associated with aging, thereby improving functional capacity. [7,8] Studies have proven that flexibility training along with strength training is beneficial in improving physical performance of elderly. [8,9] Similarly, studies on balance training in elderly suggested improvement in mobility function and reduction in the likelihood for falls among community-dwelling older adults. Together, these training (strength, flexibility and balance) will greatly improve the functional capacity of older men and women, therefore improving their quality of life and extend independent living. [7-10]

Available literature has proven that a well designed exercise intervention program improves body strength, flexibility and balance in elderly thereby improving quality of life. With the growing numbers of elderly population in Nepal, it is good to start exploring programs to improve quality of life of elderly population. Hence this study designs a group exercise program and evaluates its effectiveness among the elderly population in reducing number of falls thereby improving strength, flexibility and balance.

MATERIALS AND METHODS

The subjects were randomly selected from Dhulikhel community. Among the 28 participated for screening, 15 fulfilled the inclusion criteria and were included in the study. A written informed consent was obtained from the participants after explaining the study procedure. The subjects were recruited in the study based on following inclusion and exclusion criteria:

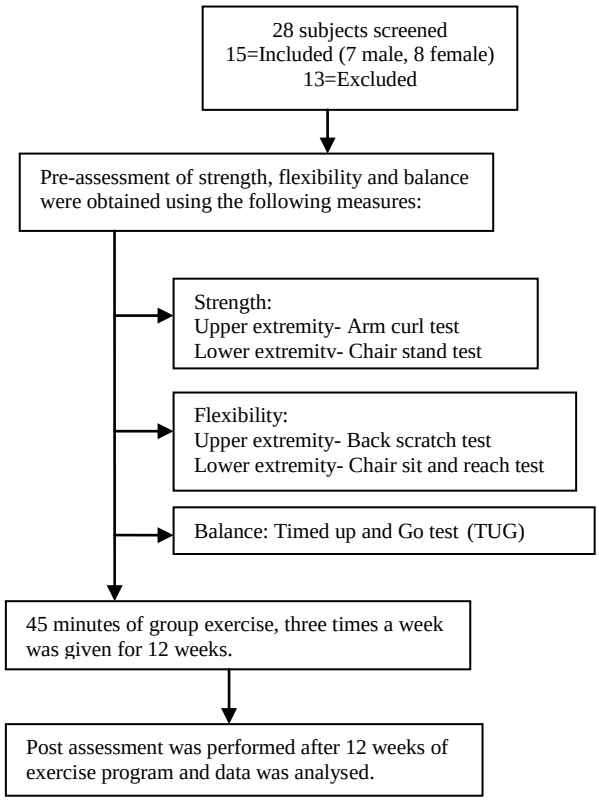

Figure 1: Flow diagram: Subject's selection and Study methodology

Table 1: Tests used for assessing strength, flexibility and balance

	Upper extremity	Lower extremity
Strength test [11-13]	**Arm curl test**: The subject sits on a chair, holding a dumbbell (5 pound: female, 8 pound: male) in the hand using a cylindrical grip with the arm in a vertically down position beside the chair. Brace the upper arm against the body and curl the arm up through a full range of motion, gradually turning the palm up. Lower the arm through the full range of motion, gradually returning to the starting position. Repeat this action for 30 seconds.	**Chair stand test:** The subject sits in the middle of the seat, with their feet shoulder width apart, flat on the floor. The arms are to be crossed at the wrists and held close to the chest. From the sitting position, the subject stands completely up, then completely back down, and this is repeated for 30 seconds.
Flexibility test [11-13]	**Back scratch test:** This test is done in the standing position. Place one hand behind the head and back over the shoulder, and reach as far as possible down the middle of back, palm touching body and the fingers directed downwards. Place the other arm behind back, palm facing outward and fingers upward and reach up as far as possible attempting to touch or overlap the middle fingers of both hands. If the fingertips touch then the score is zero. If they do not touch or overlap, measure the distance between the finger tips.	**Chair sit and reach test:** The subject sits on the edge a chair. One foot must remain flat on the floor. The other leg is extended forward with the knee straight, heel on the floor, and ankle bent at 90°. Place one hand on top of the other with tips of the middle fingers even. Ask subject to inhale, and then as they exhale, reach forward toward the toes by bending at the hip. Keep the back straight and head up. Keep the knee straight, and hold the reach for 2 seconds. The distance is measured between the tip of the fingertips and the toes.
Balance test [14-17]	**Timed up and Go test:** An individual is asked to stand up from a standard arm chair, walk a distance of 3 meters, turn, walk back to the chair, and sit down. The time taken is recorded.	

Table 2: Exercise program

Warm up	Breathing exercises and stretches	
	Upper extremity	**Lower extremity**
Strengthening exercises (Repeat all exercises for ten times)	**Bicep Curls**: Hold the weight in hand at side of the body. Begin with shoulders straight and palm inward. Bend elbow toward shoulder while turning palm up. Return to the start position and repeat. **Triceps Kickbacks:** Lean over knee if sitting, or over a chair or table if standing. Hold the weight in hand. Straighten elbow behind you as far as comfortable. Repeat. **Overhead Press**: Starting with feet shoulder width apart, weights in hand at chest level, palms forward. Raise arms overhead straight up and out together. Lower arms to starting position and repeat.	**Calf Raises**: Stand using a chair to balance. Rise up on toes as high as possible. Return to the starting position and repeat. **Knee Extensions**: Sit in a chair with feet flat on the floor. Straighten out right knee and hold for a few seconds. Then straighten out left knee and hold for a few seconds. Repeat. **Sit to Stand**: Begin by standing with a chair behind, knees just in front of the seat. Lean forward and bend knees and lower yourself towards the chair as if attempting to sit. Before touching the chair, pause then stand back up to a full upright position and repeat.
Flexibility exercises (Repeat all exercises for five times)	**Chest Stretch**: Sit comfortably on a chair. Raise arms and place hands behind head. Breathe in while bringing neck and shoulders back. Hold briefly, then exhale, relax and repeat three more times. **Arm Raise**: Begin standing with arms comfortably at sides. Relax shoulders and lift ribs. Inhale while lifting both arms overhead. Return to the start position and repeat. **Shoulder Stretch**: Bring left hand up onto right shoulder. Support elbow with right hand. Gently pull left elbow toward right shoulder. When a stretch is felt, hold for 10 to 15 seconds. Repeat with the other side.	**Hamstring Stretch**: Select a firm surface to sit. Extend one leg out onto the surface. Slowly lean forward & reach for thigh or ankle. Hold for 20-30 seconds. Repeat on other leg. **Standing Quad Stretch**: Stand with a chair for support. Hold on with left hand. Bend right knee. Grasp right ankle. Gently pull up toward bottom. Hold for 10-20 seconds. Then repeat with the other leg. **Calf Stretch**: Stand facing a wall. Place hands on the wall. Step forward with right foot. Lean hips toward the wall. Keeping back leg straight, heel on the floor hold position for 20 to 30 seconds. Repeat with the other leg.
Balance exercises	**Dynamic Walking**: Stand at one end of living room. Begin walking while slowly turning your head from left to right. Repeat several times. **Heel to toe**: Begin by standing with one foot in front of the other. Step forward placing one foot in line with the other. Continue to step placing right foot in front of left. **Single Limb Stance:** Stand with feet together and arms at sides. Lift one leg and balance on the other. Hold for 10 seconds, and then repeat with the other leg. **Marching**: Stand with arms at sides, feet shoulder width apart. Raise one knee up as high as comfortable. Lower, and then raise the other knee. Repeat 20 times.	
Cool down	Breathing exercises, stretches	

Inclusion criteria:

- Age: 60-70 years.
- Elderly without walking aids.
- Sedentary status elderly: Those who are not being currently involved in any training and not having previously participated in any exercise programs.
- Elderly who voluntarily consent to participate in the study.

Exclusion criteria:

- Elderly who exercised regularly.
- Elderly with cardiac or pulmonary disease, a terminal illness, severe joint pain, dementia, medically unresponsive depression, or progressive neurologic disease.

15 elderly (60-70 years) were included in the study. After the collection of demographic data an initial assessment were made using tests from Senior Fitness Test Protocol [11-13] for testing strength and flexibility and timed up and go test was used for balance assessment (Table 1).

A well designed group exercise program was then administered to the group for 12 weeks. 45 minutes of exercise program was given for 3 days a week (Table 2).

Data analysis

Stata/MP 13.0 data analysis and statistical software was used to analyze the data.Thelevelofsignificance<0.05wasconsideredtobestatisticallysignificantwith95%confidenceinterval.The tests used in the analysis were: one sample t-test, paired t-test, and Pearson's correlation test.[1]

[1]An assumption underlying the t-tests and the Pearson correlation test is that the data come from a normal distribution. It is not possible to test normality with the relatively small sample size used in this study. As a robustness check, for the one-sample t-test, we conducted a nonparametric test, the one-sample median or signed-rank test; for the paired t-test we conducted the nonparametric Wilcoxon signed rank test; and for the Pearson correlation test we conducted the nonparametric Spearman rank correlation test. These alternative tests do not require the normality assumption. Only parametric test results are reported, however, results generally hold under the nonparametric tests too.

RESULTS

Strength (Table 3)

Prior to the exercise program, the average lower extremity strength for female participants was 9.5, which was lower than the cutoff of 11 (p=0.0047) at 1% level of statistical significance. Likewise, for male participants, the average lower extremity strength was 11.43, slightly lower than the cutoff of 12 (p=0.0515) but the difference was not statistically significant at 5% level. After the exercise program the average lower extremity strength for females and males increased to17.63 and 20, which was statistically significantly higher than the cutoff of 11 and 12 (p=0.0001, p=0.0001) respectively at 1% level.

Similarly, before the exercise program the average upper extremity strength for female participants was 11.38, which was lower than the cutoff of 12 (p=0.0246) at 5% level of statistical significance. For male participants, the average upper extremity strength was 13.71, lower than the cutoff of 15 (0.0002) at 1% level of statistical significance. Post exercise program, the average upper extremity strength for females and males increased to 19.25 and 22.57, which was statistically significantly higher than the cutoff of 12 and 15(p=0.0001, p=0.0001) at 1% level.

Flexibility (Table 3)

Prior to the exercise program, the average lower extremity flexibility for female was -1.25, which was lower than the cutoff of -0.5 (p=0.0071) at 1% level of statistical significance. And for male participants, the average lower extremity flexibility was -3.43, lower than the cutoff of -3 (p=0.0391) at 5% significance level. Post exercise program, the average lower extremity flexibility for females increased to 5.25 (p=0.0001) and males increased to 3.79 (p=0.0001), which was statistically significantly higher than the cutoff at 1% level.

Upper extremity flexibility before exercise for female and male participants was 6.25 and 8.57, which was higher than the cutoff of 3.5 (p=0.0001) and 7.5 (p=0.0057) respectively at 1% level. After the exercise program, the average flexibility for females decreased (improved) to 2.25 (p=0.0001), which was lower than the cutoff at 1% level. For males, the average upper extremity flexibility decreased (improved) to -1.43 (p=0.0001), which was lower than the cutoff at 1% level.

Table 3: Pre and post assessment of strength, flexibility and balance.

Outcomes	Gender	N	Mean		Difference between pre & post means, pooled
			Pre	Post	
Strength					
Lower extremity: Chair stand test	F	8	9.5 (0.423) p=0.0047***	17.625 (0.498) p=0.0001***	-8.333 (0.386) p=0.0001***
	M	7	11.429 (0.297) p=0.0515*	20 (0.378) p=0.0001***	
Upper extremity: Arm curl test	F	8	11.375 (0.263) p=0.0246**	19.25 (0.313) p=0.0001***	-8.333 (0.347) p=0.0001***
	M	7	13.714 (0.184) *** p= 0.0002	22.571 (0.481)*** p=0.0001	
Flexibility					
Lower extremity: Chair sit and reach test	F	8	-1.25 (0.231) p=0.0071***	5.25 (0.134) p=0.0001***	-6.833 (0.193) p=0.0001***
	M	7	-3.428 (0.202) p=0.0391**	3.786 (0.264) p=0.0001***	
Upper extremity: Back scratch test	F	8	6.25 (0.366) p=0.0001***	2.25 (0.164) p=0.0001***	6.8 (0.852) p=0.0001***
	M	7	8.571 (0.297) p=0.0057***	-1.428 (0.202) p=0.0001***	
Balance					
Timed up and go test	F	8	12.875 (0.350) p=0.9412	8.25 (0.412) p=0.0001***	4.6 (0.306) p=0.0001***
	M	7	12.428 (0.297) p=0.9943	7.857 (0.143) p=0.0001***	
	Both	15	12.667 (0.232) p=0.9985	8.066667 (0.228) p=0.0001***	

Standard errors in parenthesis. P-values reported below the standard errors.
*** p<0.01, ** p<0.05, * p<0.1
In columns Pre and Post, the test performed is a one-sided t-test where the null is that the mean is equal to the cutoff. In the last column, the test performed is a one-sided paired t-test on a pooled sample of male and female patients where the null is that there is no difference between the pre and post means. See text for details, including relevant cutoffs and the direction of alternative hypothesis.

Balance (Table 3)

Before the exercise program, the average balance for females and males was 12.88 and 12.42, which was not significantly higher than the cutoff of 13.5 (p=0.9412). For males and females combined (both have the same cutoff), the average balance was 12.67, which was not significantly higher (p= 0.9985) than the cutoff. Post exercise program, the average balance score for females and males decreased (improved) to 8.25(p=0.0001) and 7.86 (0.0001), which was lower than the cutoff at 1% level. For males and females combined, the average balance score, post exercise program, decreased (improved) to 8.07, which was

statistically significant (p=0.0001) at 1% level.

All five outcomes have improved after the group exercise program on average. Now let's test whether the differences in mean outcomes are statistically significant. Males and females were pooled to increase sample size[2] and a parametric paired t test was employed. Statistically significant improvement in all the outcomes (p=0.0001) was found following post exercise program at 1% level.

A priori, we would expect improved balance to be associated with improved lower extremity strength. The Pearson's correlation between change in lower extremity strength and change in balance for the sampled patients indicate a weak association in the expected direction (coefficient of -0.1211), but it is not statistically significant.

DISCUSSION

This study demonstrated that a simple exercise program can improve strength, flexibility and balance in elderly.

Significant improvement in strength post exercise program was found in this study. Literature suggests that strength losses occur at the rate of about 12 to 14% per decade after the age of about 50 years, [18-20] and 30% strength gains occur within the first couple of months of heavy resistance strength training in 65 to 75 year-old men and women. [21] Thus, about 2 months of strength training essentially reverses at least 2 decades of strength loss with advanced aging. Similar change can be observed in muscle mass, which is lost at a rate of about 6% per decade after the age of 50 years [19] and can be increased by about 12% within the first couple of months of strength training. [22] Thus, 2 decades of age-induced muscle mass loss can be reversed with only about 2 months of strength training. A study done to evaluate the strength training in elderly suggests that maximal motor unit recruitment rates [23-26] are likely contributors to the substantial increases in strength after short term strength training.

Similarly upper and lower extremity flexibility was found to improve significantly post exercise in elderly in this study. Literature suggests that after six weeks of training, the twice-weekly resistive or flexibility exercise promoted an increase in the cardiorespiratory capacity and lower limb strength of older individuals. [27] Another study found that an active stretching program, performed twice a week for 4 weeks, was effective in increasing knee flexor and extensor isokinetic torque and functional mobility in older women. [28]

Balance was also found to significantly improve post exercise among the elderly. Our flexibility exercise protocol included stretches for the gastrocnemius and soleus muscles, which would be expected to increase dorsiflexion range of motion. Previously, correlations have been reported between reduced ankle-dorsiflexion range of motion and improvement in balance. [29] Improvements in balance may be related to changes in ankle range of motion, although this was not measured in the study. Another study has concluded that following a 12-week program of dynamic resistance strength training, older adults showed improvements in gait speed and balance. [30] Cochrane review has suggested that exercise appears to have statistically significant beneficial effects on balance ability compared to usual activity. Exercises involving gait, balance, co-ordination and functional exercises; muscle strengthening; and multiple exercise types, appear to have the greatest impact on indirect measures of balance. [31]

[2] Here we are not comparing outcomes with the cutoff, which varies across gender, so we pool males and females together.

A major limitation of the study was a relatively small sample size and short follow-up period limited the study power.

CONCLUSION

Developing a community-based group exercise program is one means of enabling older adults to take part in physical activity and exercise. Results from this study suggest a multidimensional group exercise program is an important factor in improving strength, flexibility and balance in older community-dwelling adults wishing to improve their quality of life.

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