Efficacy of Combined Exercises for Balance, Mobility and Strength to Reduce Risk Falls in Elderly Subjects

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ABSTRACT

This study was conducted to investigate the effect of exercise programs of balance, mobility, and strength to reduce falls in elderly population. A total of 60 subjects with age 65:80 years with previous falling history participated in the study. The subjects were divided into three equal groups (1) a control group received no exercise program, (2) exercise group 1 received a program of balance exercise and mobility exercise, and (3) exercise group 2 received a program of balance exercise and strengthening exercise. The exercise program was delivered twice daily 6 days/week for three months. Each subject is evaluated before and after the exercise program using balance test and functional mobility test. Analysis of the data revealed that both exercise groups were significantly higher than the control group on all measures of balance and mobility tests, the significant difference was clear between groups in tandem stance and single limb stance, P< 0.0001. when comparing each exercise group to control there was significant increase of both exercise groups than control group P=0.001. In addition when comparing both exercise groups regarding the five conditions of the balance test there was increase of exercise group 1 than exercise group 2 but this increase was not significant where P< 0.2. Four months followup revealled only 1 fall due to environmental hazards among the exercise groups and 3 falls among non exercise group. In conclusion multidimensional exercise can improve balance and mobility function which could be reflected on reducing the falling frequency of older individuals with emphasizing on the preferable effect of combined balance and mobility exercises than combined balance and strengthening exercises.

Key Words: *Exercise, Balance, Elderly Subjects.*

INTRODUCTION

The risk for fall increases with age[2,20]. In people over the age of 65 years, falls are considered as the leading cause of death from injury[14]. Because of the devastating effect of falls among older adults, risk factors for predicting falls and falls related injuries have been studied extensively[14,15,23]. Factors contributing to increased risk for falls in geriatrics have been titled as changes in muscular strength[1], decreased joint mobility[7], impaired static and dynamic balance[6,23] in addition to impaired visual sensation[13], decline in vestibular function and decreased vibratory sense[21]. All these factors increase the probability for falls among older adults.

Because of the multifactors reported to contribute to increase risk falls among

geriatrics, several studies have investigated the effect of exercises on posture balance and gait in older adults and reported mixed results[4,9,13,19]. Comparing results from these various studies can be difficult because of the diversity of the used exercise programs, in addition many researches have utilized exercise into a multifaceted intervention approaches making it difficult to determine the relative contribution of exercise in improving balance and decreasing fall risk. The effect of another type of exercises on gait in older subjects was studied by Topp et al. (1993), who demonstrated a relationship between resistance strength training and improvement in gait speed and balance in older adults[25].

Recently, it had been reported that a multifocus interventions in the form of exercise program to improve balance and ability to transfer safely proved to reduce the rate of falls among community dwelling adults[24]. Another meta-analysis study was conducted to examine the effect of exercise on falls and concluded that balance retraining seems to be effective type of exercise for reducing fall risk[17]. The effect of multidimentional exercises on balance, mobility, and risk falls in community-dowelling older adults was studied and the reported results confirmed that exercise can improve balance and mobility function and reduce the likelihood for falls, but the amount of exercise needed to achieve these results could not be determined from this study[3].

So, the purpose of this study was to examine the effect of a well designed specific multidimensional exercise program on risk falls in elderly persons. Our hypotheses that there is a significant difference between the exercised groups and no exercise group and no significant difference between the exercised groups.

MATERIALS AND METHODS

Subjects

A total of 60 subjects with age 65-80 years and mean age 72 ± 3.4 year. Participated in this study. The subjects were selected from (Ever Green Geriatric Nursing Home. Helwan) and reported history of two or more falls in the previous six months. All participants were free from neurologic or heart problems that would prevent safe performance of exercise. Also they were not currently receiving physical therapy. Participants performed this study from Oct 2000 to Dec 2000.

The subjects were divided into three equal groups, each included 20 subjects. (1) a control group received no intervention, (2) exercise group 1 received a program of balance and mobility exercises, (3) exercise group 2 received a program of balance exercise and strengthening exercise.

Testing procedure

All subjects underwent an assessment and scoring of balance test and functional mobility test.

Balance in steady standing

The ability to maintain stance position with eye opened and without hand support was recorded for each subject. The stance positions as specified in the protocol described by Goldie et al. (1990)[5] were as following.

1- Stand feet 10 cm apart.
2- Stand feet together.
3- Stride stance with subject's feet placed 10 cm apart with the heel of the front foot in line with toes of the rear foot.
4- Tandem stance, in which subjects stood with one foot directly in front of the other foot and with toes of rear foot contacting the heel of the front foot.
5- Single limb stance, in which the subjects stood on one foot with opposite knee held

at 45 degree of flexion and both hips in anatomical position, and subjects were asked to stood on the other foot with the previous characters.

- Subjects have to maintain the position for 30 seconds in an effort to control the effect of fatigue.
- Subjects have to do each condition 3 times, with rest in between trials equal to the time used in the trial and the best of the 3 scores was recorded.

Functional mobility test

To test the ability to do the required tasks and amount of assistance needed as specified by Weiner et al. (1993)[26] The test included five tasks with scale of three, minimum assistance of one, moderate assistance of one, and independent

1- Ability to sit from supine.
2- Ability to stand from sitting.
3- Ability to sit on chair beside bed from sitting on the edge of the bed.
4- Ability to go for a walk from sitting on a chair.
5- Ability to go to toilet.

Assessment were performed for the three groups before the initiation of the treatment programs and after three months at the end of the program.

Intervention

Exercise program as specified by Smith and Serfass (1981)[22], using chair program for lower extremity exercise. Subjects held the chair for stability during exercises in standing position. The exercises were performed at a frequency of two session per day, 6 days/week for both exercise groups, morning session and afternoon session.

Mobility exercises program: Subjects participated in exercise group 1, received mobility exercise (range of motion exercise) in addition to balance exercise twice daily. Mobility exercises program was in the form of flexion, extension, abduction, adduction, and rotation exercises within full range of motion, rhythmic type using metronome to regulate it for 12 repetitions each exercise.

Strengthening exercises program: Subjects participated in exercise group 2, received strengthening exercise for lower extremity in addition to balance exercise twice daily from the same position using (2 Kilo, 4.5 Ib) (Innovative Rehab Systems sand bags) fixed just above ankle joint. Subjects were asked to do the exercises program with full range of motion, rhythmic using metronome to regulate it for 12 repetition each exercise (6 repetitions with 2 minutes rest equal to the time of exercise, then another 6 repetitions).

Balance exercise program: All patients in exercise groups 1 and 2 received a combination of two protocols of balance exercises designed to improve patient's balance.

As patient received two sessions per day. In morning session subjects participated balance exercise described by Goldie et al. (1990)[5]. The exercise was delivered as described in the test with rest period of two minutes between each condition of the test. Each condition was repeated 6 times.

In the afternoon session, subjects participated balance exercise described by Wulfson et al. (2001)[28].

1- Subjects stand on balance board (60 cm diameter with 20 cm base). Subjects have to maintain balance in standing for 30 seconds at 6 trials for first month.
2- Subjects stand on balance board (60 cm diameter with 15 cm base). Subjects have to maintain balance in standing for 30 seconds at 6 trials for second month.
3- Subjects stand on balance board (60 cm diameter with 10 cm base). Subjects have

to maintain balance in standing for 30 seconds at 6 trials for third month.

The multidimesional program was delivered twice daily, 6 days/week for three months.

Data Analysis

Scores of the balance tests were recorded pre and post the multidimensional exercise program for the three groups. The scores were expressed as mean Standard Error (SE) and percentage.

ANOVA test was performed for each recorded variable to determine differences among the three groups either pre or post application of the program. The pre test was to determine whether differences existed between the groups to avoid the disparity in initial performance and post the application of the program to examine the effect of the multidimensional program.

If there was difference among the three groups, further post hoc pair-wise comparisons was used to examine differences between each pair of the three groups.

RESULTS

As shown in table (1) before exercise, there were no significant differences among the three groups in all the recorded parameters of the balance test.

When calculating the percentage of the recorded scores of the balance test to the total 30 seconds of each test condition, it was noticed that before exercise the highest values were recorded for the first three conditions (feet apart, feet together, stride stance), while the lowest recorded values were for tandem stance and single limb stance.(figure 1).

Table (1): Balance scores in seconds (mean +/- SE) before exercise.

Condition	Control group	Exercise group 1	Exercise group 2	F	P
Stand feet 10 cm apart	29.47 ± 0.69	29.18 ± 0.46	29.45 ± 0.69	0.17	0.1
Stand feet together	29.18 ± 0.59	29.02 ± 0.69	29.12 ± 0.82	0.23	0.1
One foot in front of the other	28.17 ± 1.59	28.03 ± 1.76	28.15 ± 1.20	0.79	0.1
Tandem stance	15.64 ± 1.90	16.92 ± 1.12	17.07 ± 1.36	2.01	0.2
Single limb stance	9.53 ± 1.07	9.72 ± 1.18	10.03 ± 1.92	1.65	0.2

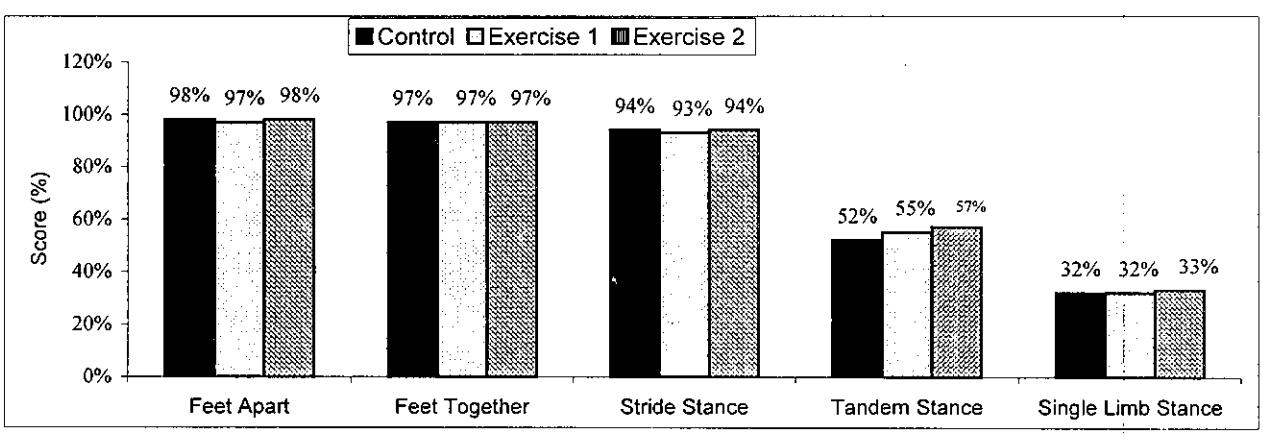

Fig. (1): Percentage of balance test scores for the studied groups before the exercise program.

After performing the exercise program, there was improvement in the all balance scores of the subjects in both exercise groups as evidenced by the increase in the percentage of balance scores recorded in relation to the total 30 seconds test as shown in (figure 2).

After Exercise, there were significant differences among the studied groups in tandem stance and single limb stance where P< 0.0001 and no significant differences were found at the other parameters of the balance test (table 2).

Concerning tandem stance and single limb stance, post hoc test revealed significant improvement of both exercise groups compared to the control group as P=0.001. but when comparing exercise group 1 to exercise group 2 there was no significant difference between them P< 0.2.

Table (2): Balance scores in seconds (mean +/_ SE) after exercise.

Condition	Control group	Exercise group 1	Exercise group 2	F	P
Stand feet 10 cm apart	29.71 ± 0.28	30.00 ± 00	30.00 ± 00	0.17	0.1
Stand feet together	29.56 ± 0.36	30.00 ± 00	30.00 ± 00	0.82	0.1
One foot in front of the other	28.32 ± 1.40	30.00 ± 00	30.00 ± 00	0.28	0.1
Tandem stance	16.92 ± 1.81	29.01 ± 0.61	28.17 ± 0.59	10.7	0.0001*
Single limb stance	10.76 ± 1.5	26.36 ± 2.03	25.41 ± 2.61	10.1	0.0001*

* Significant

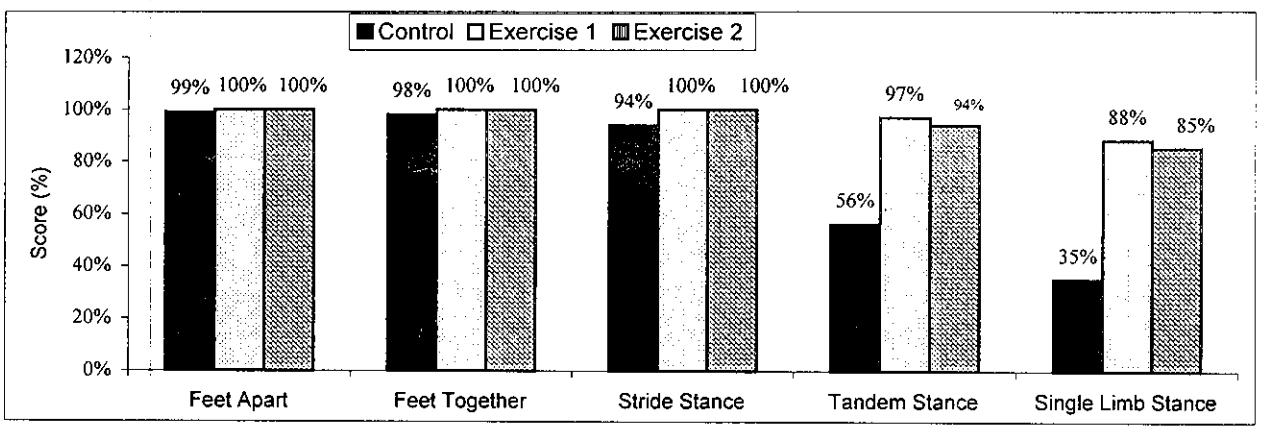

Fig. (2): Percentage of balance test scores for the studied groups after the exercise program.

The functional mobility test results showed that the exercise program improve the condition of subjects in both exercise groups from being dependent with degrees on others for transfer to a totally independent in all the tested conditions (table 3).

Table (3): Functional mobility test before and after exercises.

Condition	Control group		Exercises group 1		Exercise group 2	
	Before	After	Before	After	Before	After
Supine to sit	Indep	Indep	Indep	Indep	Indep	Indep
Sit to stand	Min A X 1	Min A X 1	Min A X 1	Indep	Min A X 1	Indep
Bed to chair	Min A X 1	Min A X 1	Min A X 1	Indep	Min A X 1	Indep
Chair to walk	Mod A X 1	Mod A X 1	Mod A X 1	Indep	Mod A X 1	Indep
Bed to toilet	Mod A X 1	Mod A X 1	Mod A X 1	Indep	Mod A X 1	Indep

- Indep : Independent.
- Min A X 1 : Minimum assistance of one.
- Mod A X 1: Moderate assistance of one.

Four months followup after the exercise program, the number of falls were recorded from the participants files at Ever Green Geriatric Center, and the cause of falls. Three cases among the control group (two cases due to loss of balance when they wanted to go to toilet at midnight, one case due to blury vision). Also one case was reported among the exercise group due to environmental hazards (table 4).

Table (4): Number of falls after 4 months exercise program.

Condition	Control group	Exercise group 1	Exercise group 2
Number of falls	3	0	1

DISCUSSION

The current study was designed to investigate the effect of multidimensional exercise on risk falls in old subjects. We focused on using two forms of combined balance exercise with mobility exercise (range of motion exercise) in one group and balance exercise with strengthening exercises in another group to select an easy program that elder subjects can perform it safely.

Our results showed that a multidimensional exercise program can improve balance and mobility, hence decreasing fall risk in old age subjects, since the number of falls was only one case after four months followup, and it was due to environmental hazards compared with three cases in non exercise group.

These results are in consistent with other reported studies that demonstrated that multidimensional exercises can help to reduce falls or risk falls. Tinetti et al. (1994) reported reduction in the rate of falls among community dwelling older adults after participating in a multifocused exercises designed to improve balance and ability to transfer[24]. Cook et al (1997), conducted prospective clinical investigation to examine the effect of multidimensional exercise program on balance, mobility and fall risk in community dwelling older adults with a history of falling. The authors concluded that multidimensional exercise can improve balance, mobility and reduces fall risk in older adults, but in this study the exercise program was poorly explained or discussed and both the amount and type of exercise needed to achieve the reported results were not identified[3].

As the problem of this study was multifactorial, our multidimensional exercise program was based on developing efficient balance, mobility, and strength and improving the subject ability to adapt to changing

environment, using a well designed program of exercise to be followed. Until now, the effectiveness of this kind of approach has not been studied thoroughly and the reported multidimensional studies lack the specification of the exercise program used.

The multidimensional exercise program utilized in the current study included multiple approach of balance, mobility and strengthening exercises. It was reported that exercise designed to improve balance are an important part of fall prevention[9]. Lack of mobility and decrease joint flexibility was addressed as a contributing factor for fall in older subjects[7]. Improving mobility skills enables subject to make the appropriate postural adjustement[4]. Strengthening exercises provides sufficient force production of the lower limbs and trunk muscles for postural support[25].

Our results also demonstrated that there were tendency towards increase in balance scores of exercise group 1 received a program of combined balance and mobility exercises than exercise group 2 received a program of combined balance and strengthening exercises but this increase was not significant. This indicated that both exercise protocols are of benefit to improve balance and reduce falling with emphasizing that combined balance and mobility exercises, following the protocols applied in this study may have better results than could be achieved by combined balance and strengthening exercises.

In a meta-analysis study conducted by Province et al. (1995), to examine the effect of exercises on fall risk among old subjects at different centers, it was reported that despite the mixed outcome among the different sites involved in the study, it seems that some forms of balance training appeared to be the most effective type of exercise for reducing fall risk[17].

The current study examined the effect of exercise on balance and mobility and not directly on actual frequency of falls, balance tests has been highly related to actual fall frequency. The use of balance as a measure of the exercise effectiveness has been reported by others where it was reported that improving balance and mobility skills are associated with a reduction in falls among older adults[3,10,24].

CONCLUSION

The results of the current study directed the attention that a multidimensional exercise program can improve the older subjects balance and attribute to decrease the risk falls with its devastating effect in subjects over the age of 65 years. In addition combined balance and mobility exercises is recommended over combined balance and strengthening exercises. Further study is needed to determine the effect of multidimensional exercise on posture and gait pattern and its relation to falling in geriatrics using recent technology of motion analysis systems. Four months followup, rported one case of falls in the exercise groupsdue to environmetal hazards compared to three cases in non exercise group.

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الملخص العربي

اثر تمرينات الاتزان والمرونة وتمرينات القوة العضلية لتقليل مخاطر السقوط لكبار السن

استهدفت هذه التجربة دراسة اثر تمرينات الاتزان والمرونة وتمرينات القوة العضلية لتقليل مخاطر السقوط لكبار السن لمدة ثلاثة اشـــهر متتالية مرتين يومياً / ٦ أيام في الأسبوع اشترك في هذه التجربة ٦٠ مسناً تتراوح أعمارهم بين ٦٥ و ٨٠ سنة قسموا إلى ثلاثة مجموعات احتوت كل مجموعة على ٢٠ مسناً المجموعة الضابطة احتوت على ٢٠ مسناً ، مجموعة التمرينات الأولى "الاتزان + تمرينات الـــتقوية العضـــلية " ومجموعة التمرينات الثانية " الاتزان + تمرينات المرونة" ، تم عمل القياسات اللازمة قبل التجربة و بعدها من قياس الاتـــزان و وظائف المرونة حيث أسفرت النتائج الأولية قبل التجربة عن عدم وجود فوارق ذات دلالة إحصائية في الاختبارات و لكن بعد ثلاثة أشـــهر من العلاج المتعـــدد الأبعـــاد كانت هناك فوارق إحصائية بين مجموعتي التمرينات و المجموعة الضابطة حيث كانت الدلالة الإحصائية اقل من ٠,٠٥ وبتطبيق اختبار هوك المزدوج بين مجموعتين التمرينات وجد أن المجموعة الثالثة "الاتزان + تمرينات المرونة" افضل في نتائجها من المجموعة الثانية " الاتزان + تمرينات التقوية " ولكن لا توجد دلالة إحصائية . أثبتت هذه الدراسة أن حالات السقوط المســـجلة فـــي المجموعة الضابطة كانت ثلاثة حالات بعد أربعة أشهر متابعة لهذه الدراسة وحالة واحدة في مجموعة البحث نتيجة عرقلة بأثاث الغرفة . كما أثبتت هذه الدراسة نتائجها أن التمرينات المتعددة الأبعاد لها اثر واضح في منع السقوط الذي قد يؤدى إلى إصابات في الجهـــاز العظمـــى العضلي و أن تمرينات المرونة بالإضافة إلى تمرينات الاتزان هي الأفضل في النتائج عن تمرينات التقوية مضافا إليها تمرينات الاتزان ...