Jumping combined exercise programs reduce fall risk and improve balance and life quality of elderly people who live in a long-term care facility

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Aim. The objective of this study was to determine whether regular combined exercise program, which consists strength, stretching and aerobic exercises and additional jumping training, improve balance, fall risk, quality of life and depression status of older people living in a residential care.

Methods. A total of 168 residents who live in a long term care facility were screened. The trial began with 78 eligible participants and they were randomly grouped as combined exercises program (COM) group that includes stretching, strength and aerobic exercises, and COM plus jumping (COMpJ) group. 66 of the participants finished the trial. The groups were convened three times a week for six weeks. Each group had a warm-up, effective training and a cooling down periods. The total exercising time was no longer than 45 minutes in each group. Berg balance test and Biodex Balance System for the assessment of the dynamic balance and fall risk, short form 36 (SF 36) for the health related quality of life and Geriatric Depression Scale (GDS) for evaluation of the depression status were used.

Results. The balance improvement and fall risk reduction were observed in both of the groups at the end of the trial; however, the improvements were statistically better in jumping combined group. Also health related quality of life improved in both groups.

Conclusion. Regular group exercise in a long term care facility have several beneficial effects on the elderly residents in regard to balance improvement, fall risk reduction and quality of life. The addition of jumping to strength, stretching and aerobic exercises provides important contributions to balance improvement and fall risk reduction.

KEY WORDS: Motor Activity - Accidental falls - Quality of life - Aged - Exercise.

Falls and fall related injuries are a major health problem among elderly people. Approximately 30% of people over 65 years of age and living in the community fall each year. Fall rates in residential care are three times those of the elderly people living in the community, and hip fractures are 10.5 times more likely than they are for community dwellers. The fact that only 15% of those who fracture their hip regain their pre-injury functional level places a large burden of care on staff.1-3

It has been well established that the motor and sensory systems of postural control change with increasing age result in postural instability and problems with balance. This is likely to be related to the increased incidence of falls in elderly individuals.4-6
Falls have devastating consequences and are accompanied by pain, reduced mobility and unacceptably high levels of caregiver stress. Therefore, interventions regarding fall risk assessment, fall prevention and fall risk reduction in elderly people, particularly those living in long term care facilities, have become integral components of a thorough geriatric care.7

Exercises have been shown to be an effective method of preventing falls in elderly individuals, especially when balance and strength training are combined.1, 2, 8 However, the data about the ideal exercise models to prevent the falls in long term care facilities has not been established yet.

Long-term care facility residents probably have increased frailty compared with their community dwelling counterparts. It has also been shown that most residents’ physical functioning deteriorated or remained stable after admission to a long-term care facility. Impairments which best explain changes in functioning such as range of motion or balance in standing are modifiable and should be targeted in future interventions. Therefore, the type and the intensity of exercise which are most beneficial to long term care facility residents still need clarification.7, 9

Jumping is commonly pronounced as the exercise type which maximizes the osteogenic responses of the lower extremity especially to prevent osteoporosis and related bone fractures in elderly people.10 Jumping has become a component of combined exercises programs intending balance improvement and fall prevention recently.

Appropriate exercise regimens may reduce the risk

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**Figure 1.— Flowchart.**

Assessed for eligibility (n=168)

Excluded (n=90)
- Not meeting inclusion criteria (n=79)
- Refused to participate (n=11)
- Other reasons (n=0)

Randomized (n=78)

Allocated to intervention (n=38)
- Received intervention (n=38)
- Did not receive intervention (n=0)

Allocated to intervention (n=40)
- Received intervention (n=40)
- Did not receive intervention (n=0)

Lost to follow-up (n=4)
- Discontinued intervention (n=4)

Lost to follow-up (n=3)
- Discontinued intervention (n=1)

Analyzed (n=30)
- Excluded from analysis (n=0)

Analyzed (n=36)
- Excluded from analysis (n=0)
of falls and the severity of fall-related injuries, and also constitute potential therapy to improve functional ability and the quality of life in elderly people living in long-term care settings.

The objective of this study was to determine whether regular combined exercise program, which consists of strength, stretching and aerobic exercises and additional jumping training, improve balance, fall risk, quality of life and depression status of older people living in a residential care.

Materials and methods
Study design and participants
A randomized controlled study with two experimental groups was carried out. Study participants were 65 years or older people living in a long-term care facility. A total of 168 residents were screened by analyzing the records and by interviewing with the registered nurse and the institution physician. Then, one hundred residents who were supposed to be eligible for the study, were invited to initial assessment. The initial assessments were performed after the explanation of the trial. All of them accepted the invitation and 89 participants were not found eligible according to the inclusion criteria, but afterwards 11 of the residents gave up attending the study. Finally, the trial began with 78 eligible participants (Figure 1).

The participants were randomized to two groups. Randomization was performed by using a computer-generated random number schedule by an investigator who was not involved in assessment or recruitment procedure.

The subjects had free recreational physical activity time for approximately two hours every day and there was no planned or instructed exercises activity and they were free to do or not to do any physical activities during that time previously.

The inclusion criteria were willingness to participate, age over 65, no existing illness contraindicating exercise or limiting participation to the exercise program, no uncorrected vision problems. The cognitive impairment (Mini Mental State Score <25), unregulated hypertension, decompensated or unregulated cardiac failure, congenital or acquired structural or functional limb failures such as amputation, hemiplegia, and the usage of orthosis like cane, tripod, walker were the exclusion criteria.

Intervention
The exercise groups were convened three times a week for six weeks at the gymnasium of the facility. Each group included a warm-up of 5-7 min, 20-30 min of effective training (as defined below) and a 5-7 min period for cooling down. The total exercising time was not longer than 45 minutes in each group. The groups performed the training activity under the supervision of a sport teacher and a physiotherapist. They also kept an attendance record for each of the participants. All exercises were performed with sport wears and gymnastic shoes. In order to prevent the training program being monotonous, music was played by radio at the gymnasium during the training hours.

The first group was combined exercises program (COM) group that includes stretching, strength and aerobic exercises such as fast walking, sideway walking with accelerations and decelerations, ball throwing and catching, squatting down and standing up, sitting down and getting up from an armless chair, stretching the extremities and the spine, hip abduction and extension, calf rise. The second group also did the same COM but also had an additional 10 minutes jumping. The participants had jumped vertically and as freely as they could. The jumping frequency and intensity were not limited. Although the intensity of jumping was self-paced, the participants were constantly encouraged to maintain a high level of effort with enough care by the research assistants in order to avoid falls. Resting by sitting, standing or squatting was also free during the jumping exercise period whenever they needed. This second group was called “combined exercises program plus jumping (COMpJ) group”.

Outcome assessments
Participants were assessed at baseline and at the end of the 6-week exercise period. Berg balance test and Biodex Balance System were used for the assessment of the dynamic balance and fall risk. Also, short form 36 (SF 36) for the health related quality of life and Geriatric Depression Scale (GDS) for evaluation of the depression status were used.11-13

Berg Balance Scale (Berg) was originally developed for the assessment of balance and Turkish validation was made and widely used in many fields of rehabilitation.14-16 The 14 items in the scale assess static sitting and standing balance as well as anticipato-
ry balance during activities which were commonly performed in daily function, including transfers, turning, and retrieving objects from the floor. The scoring is done on a 5-point scale which considers whether patient can perform the task safely and independently, often based on a definite time span. Normal performances are graded from 0 (unable to perform) to 4 points (normal performance). Scores on individual items are summed for a total score, with a maximum of 56 points.

Biodex Balance System (BBS, a commercially available balance device, Biodex Medical Systems, Shirley, NY, USA) was used to assess balance, neuromuscular control and fall risk. BBS consists a movable balance platform which provides up to 20° of surface tilt in a 360° range of motion and the platform is interfaced with computer software (Upper display module-firmware version 1.09, Lower control board-firmware version 1.03, Biodex Medical Systems) that enables the device to serve as an objective assessment of balance and fall risk. Following the recommendations of previous studies and Biodex balance system manual, the two setting were used to assess the dynamic balance and fall risk; postural stability test and fall risk test.17,18 The measure of postural stability includes the overall (OA), the anterior/ posterior (AP), and the medial/lateral (ML) stability scores. Fall risk test result includes overall stability index (OSI). The high score in the indexes indicates poor balance and increased fall risk. Subjects were asked to stand on the platform of the BBS bilaterally with feet shoulder width apart over midline of the board, assume a comfortable position and to look straight ahead. Foot position coordinates were constant throughout the test session. Subjects were tested without footwear at all times and with eyes open. Patients and controls were trained approximately 1 minute for adaptation to the machine in order to reduce any learning effects. During testing, the participants underwent three trials of 20 seconds each at level 8 with ten-second rest periods between each trial. A mean score was calculated from the three test evaluations and the report was prepared automatically by the device.

Statistical analysis

Data were analyzed with SPSS 15.0 software. Patients' demographic variables were analyzed by using descriptive statistics. Intra-group changes between outcomes of the baseline and end of the 6-week trial period were compared by using paired samples t-test. Also, two groups’ outcomes at the end of the trial were compared with each other by using independent samples t-test. P<0.05 value was accepted statistically significant.

Results

The COM and COMpJ groups' participant numbers were 38 and 40 at the beginning respectively. Eight from COM group and four from COMpJ group did not finish the trial or attend the final assessments. The trial finished with 66 subjects; 30 from COM group (20 female, 10 male, mean ages 81.5±6.3) and 36 from COMpJ group (20 females, 16 males, mean ages 79.4±5.4). It was important that none of the subjects were injured. There was no statistically significant dif-
ference in participants' demographic, clinical and functional measures between the two groups at the baseline (P>0.05) (Table I).

Balance and fall risk assessments

The Berg score, OA and ML scores of postural stability test and OSI score of fall risk test improved at statistically significant levels at the end of the trial according to the baseline in the COM group (P values; 0.003, 0.007, 0.0001 and 0.004, respectively).

The Berg score, OA, AP and ML scores of postural stability test and OSI score of fall risk test improved at statistically significant levels at the end of the trial according to the baseline in the COMpJ group (P values; 0.0001, 0.0001, 0.0001, 0.0001, 0.001, respectively).

The improvements at Berg score, OA and AP scores of postural stability test and OSI score of fall risk test were statistically better in COMpJ group according to COM group at the end of the trial (P<0.05) (Table I) (Figures 2-5).
Health related quality of life with SF 36

The social functioning, role limitations due to emotional problems and vitality/energy/fatigue subscale scores in COM group (P values; 0.042, 0.033 and 0.034, respectively) and physical functioning, social functioning, role limitations due to emotional problems and vitality/energy/fatigue subscale scores in COMpJ group (P values; 0.041, 0.036, 0.044 and 0.035, respectively) improved at statistically significant levels at the end of the trial according to the baseline. There were no statistically significant differences between the groups at the end of the trial (P>0.05) (Table II).

Depression status with GDS

There were not any statistically significant differences neither at intra-group comparisons nor at intergroup comparisons at any time of the trial (P>0.05) (Table II).

Discussion

Falls among elderly people are a target for public health preventive efforts, because they are relatively common, a high cost to the community, and potentially preventable. They also carry a significant burden of morbidity and mortality and affect lifestyle choices.19,20

There were several clinical trials which identify the strategies in reducing the incidence of falls such as risk factor detection and abatement programs, exercise interventions, environmental modification, or multifactorial intervention programs. They include fall-risk assessments, medication adjustments, exercise intervention, environmental hazard adjustments, and fall-risk education. These interventions generally involve community-dwelling geriatric patients and the data about the long-term care facility residents are fewer and less conclusive.7

In present study, the effectiveness of two regular exercise programs on long-term care facility residents were investigated with regard to balance, fall risk, health related quality of life and depression status. The stretching, strength and aerobic exercises were commonly recommended exercises for improving balance and reducing falls. Jumping is commonly recommended especially for osteoporosis prevention, and as a part of some balance exercises. Therefore most of the previous studies about jumping were gen-
eraly related with osteoporosis basically. It was previously shown that the jumping increases bone quality via maximizing the osteogenic responses, but it was not known whether jumping is doing more than this in order to prevent falls.

The results of this study show that the regular group exercising (three times a week) of the long-term care facility residents has beneficial effects on balance and fall risk. Likewise, jumping has some additional important effects. In a previous study, Von Heideken Wågert et al. evaluated high-impact exercises (including jumping) and combined balance and leg-strength training, with and without raloxifene treatment, in three healthy elderly women, aged 68-71 years. The 40-week study period consisted of two 17-week exercise periods with a 6-week rest period in between. The high-impact exercises included maximal vertical jumping on the floor; landing on one leg and both legs, maximal jumping in different directions, jumping from a block vertically and in different directions, and “heel-drops”. And a weighted belt was worn around during the jumping down from the block and the heeldrops. The results showed that this kind of high-impact exercise had limited effects on BMD, but had large positive effects on balance, gait speed, and leg extensor strength and improves fall risk factors in the elderly women. In another randomized, double-blind, placebo-controlled 12-month study, Uusi-Rasi et al. evaluated effects of weight-bearing jumping exercise and oral alendronate, alone or in combination, on the mass and structure of bone, risk factors for falling (muscle strength and power, postural sway, and dynamic balance) and cardiorespiratory fitness in postmenopausal women. A total of 164 healthy, sedentary, early postmenopausal women were randomly assigned to one of four experimental groups: 1) 5 mg of alendronate daily plus progressive jumping exercise; 2) 5 mg alendronate; 3) placebo plus progressive jumping exercise, or 4) placebo. They concluded that alendronate is effective in increasing bone mass at the lumbar spine and femoral neck, while exercise is effective in increasing the mechanical properties of bone at some of the most loaded bone sites, as well as improving the participants’ muscular performance and dynamic balance. Together alendronate and exercise may effectively decrease the risk of osteoporotic fractures. The positive results of these two studies about the balance improvement and fall risk reduction coincide with our results, although some differences between the jumping protocols, the duration of the exercises, and the number of the participants were present.

In some other studies, some investigators tried to identify the mechanism of the jumping’s effects on balance and fall risk. Wang and Chang investigated the transferability of the skills which were gained from the practice of jumping activity to the walking balance. They recruited fourteen handicapped children (with diagnosis of mental retardation and Down’s syndrome) and sixty-one non-handicapped children that serve as normative comparison group. The results implicated that the jumping activity might effectively evoke the automatic and dynamic postural control. Moreover, the significant improvements of the floor walk and beam walk performances might be due to the transferred effects via the practice of dynamic jumping activity. Some various exercise protocols for balance improvement and fall prevention at long-term care settings were assessed previously. In a study, 74 nursing home residents (49 females, 25 males), who were consecutively referred to physical therapy for problems related to poor balance or gait or a recent fall, received a four week (20 sessions) problem-oriented exercise program. This program specifically targeted balance and gait deficits which were identified from the problem-oriented assessment of mobility. The retest was given after four weeks of training and it was seen that both balance and gait significantly improved after a four-week intervention program. In another study, Gu et al. conducted a trial to determine the effect of a tailored falls prevention exercise for elderly adults living at nursing homes (experimental group 29, control group 30; exercise for 16 weeks, three times a week, 50 min every session). The results suggest that tailored falls prevention exercise for elderly adults can improve muscle strength, static and dynamic balance and decrease the fall frequency of elderly adults. Lazowski et al. conducted a randomized study evaluating the group exercise programs for elderly people in long-term care institutions (68 residents, 45 minutes, three times per week, four month long). They found out that Fitness for Long-Term Care Program, which was designed to maintain ROM, and also to improve strength, balance, flexibility, mobility, and function, exercise, led to significant improvements in mobility (16%), balance (9%), flexibility (36%), knee (55%), and hip (12%) strength. It was obviously seen that exercising protocols were generally three times a week and the mean session duration was approximately 40-50 minutes like ours. The
positive outcomes of these trials seem to be proving the effectiveness of the frequency and the intensity of the exercise protocols in general.

In this study, the social functioning, role limitations due to emotional problems and vitality/energy/fatigue scores of quality of life were improved in both of the groups. Additionally, the physical functioning score of quality of life assessment was improved in combined exercises program plus jumping group. This showed that regular stretching, strength and aerobic exercises have some positive effects on quality of life and jumping have additional positive effect on physical functioning. In a recent controlled study on community dwelling elderly people (aged over 65 years), Inokuchi et al. investigated the effects of exercises on 144 participants in the intervention group, which comprised a weekly exercise class of two hours for 17 weeks, supplemented by daily home exercises and social programs. The 124 participants in the control group participated only in the social program. They concluded that exercise program significantly improved physical function and emotional status and reduced the number of falls and risk factors for falls. In another study, Luleci et al. assessed the factors affecting the quality of life on 107 nursing home residents and identified that quality of life scores were positively associated with participation in physical exercise.

Limitations of the study

This study has some limitations. First, the six week duration of the exercising period was relatively short. However, the positive results of the trial showed that the exercise protocols of this study seemed effective in an earlier period. On the other hand, it sometimes could be very difficult to convince people to keep on attending the protocol. The second was that the fall risk reduction was assessed with a computerized balance and fall risk assessment device. Probably, the monitoring of fall rate changes by screening the participants for a longer duration should be more beneficial, although the used methods in this trial were validated previously for the fall risk assessment.

Conclusions

Finally, the results of this study showed that regular group exercise in a long-term care facility have several beneficial effects on the residents in regard to balance improvement, fall risk reduction and quality of life. Moreover, the results were encouraging for the involvement of the jumping as a part of regular exercising protocols for the elderly people who live in long-term care facilities because of its markedly additional positive effects on balance and fall risk according to commonly recommended stretching, strength and aerobic exercises. However, further researches with more participants and more follow up durations which monitor the daily life real fall rates are needed for strengthening the evidences.

References