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Intensive Exercise Reduces the Fear of Additional Falls in Elderly People: Findings from the Korea Falls Prevention Study

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Background/Aims: Falls among older people are a major public health problem and may result in fracture, medical complications that require hospitalization, and fear of additional falls. Given the prevalence and impact of the fear of falling again, reducing the incidence of falls is important to prevent additional falls. This study analyzed whether exercise programs decrease the fear of future falls in elderly patients who have fallen previously.
Methods: A randomized controlled study was performed that included 65 elderly community-dwelling subjects who had fallen in the previous year. Subjects were randomized into two groups: an exercise group (EG, n = 36) and a control group (CG, n = 29). The EG participated in three exercise sessions per week for 12 weeks. Muscle strength, balance, agility, flexibility, and muscular endurance were measured at baseline and after 12 weeks.
Results: After the 12-week exercise program, the subjects in the EG demonstrated remarkable improvement in their walking speed, balance (p = 0.003), back strength (p = 0.08), lower extremity strength (p = 0.004), and flexibility (p < 0.001). When asked whether they were afraid of falling, more participants in the EG than in the CG responded “not at all” or “a little.”
Conclusions: The 12-week exercise program described here reduced the fear of falling (p = 0.02). It also improved the balance, flexibility, and muscle strength of the participants and was associated with improved quality of life.

Keywords: Fear; Accidental falls; Aging; Exercise; Prevention

INTRODUCTION

The number of patients who have fallen has increased in recent years because of the rapid growth of the elderly population and the changes associated with aging. Falls among older people represent a major public health problem that has substantial medical and economic consequences [1,2]. More than one-third of people aged 65 years and older fall each year, and half of those falls are recurrent falls [3,4]. It is important to

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prevent falls in elderly people because falls can be fatal to frail seniors.

Approximately 10% of all falls result in serious injuries and hospital admission. Fall-related hospital admissions in older patients are mainly due to hip fractures (50%), arm fractures (13%), and head injuries (10%) [5,6]. More than 90% of hip fractures are fall-related injuries; hip fracture is the leading fall-related injury resulting in hospitalization and often leads to prolonged and costly hospital stays [7].

While falling is dangerous for elderly individuals, using excessive caution to avoid falls can also be harmful when the fear of falling leads to curtailment of daily activities [8]. Notably, the fear of falling is a major health problem among community-living older people, although there is great variation in the reported prevalence of a fear of falling in older people [9]. The prevalence ranges from 25% to 55% and is higher in those who have fallen previously [10,11]. This wide range may be due to differences between study samples in terms of age, sex, functional status, history of falls, measures of fear, and other comorbidities [12]. The fear of falling is thought to contribute to a loss of independence through restrictions of daily activities, which leads to slower physical performance, greater disability, and poor psychosocial function [13]. Thus, seniors in relatively good health who are fearful of falling may reduce their physical activity [14], leading to physical decline, and the fear itself may even increase the risk of falling [11].

Knowing the risk factors for fear of falling may be useful in the development of multidimensional strategies to decrease the fear of falling and thus improve seniors' quality of life [9]. Given the prevalence and impact of the fear of falling, reducing this fear is an important strategy for preventing falls. Several randomized controlled studies have shown that exercise is effective in reducing the frequency of falling in the elderly, and reviews have suggested that multifaceted programs are effective in fall prevention [15-19]. However, few studies have addressed the question of whether exercise affects the fear of falling. There is a significant correlation between poor physical function and the fear of falling, and both lead to decreased quality of life. However, it is not entirely clear which types of physical performance are correlated with the fear of falling, especially after exercise intervention.

The purpose of this study was to analyze the effects of an exercise program on the fear of falling among elderly people who have fallen before.

METHODS

Study design and subjects

This randomized controlled study, which was not double-blinded because of its nature, was performed from August 4, 2002 to December 12, 2002, at the Senior Center of Inje University Ilsan Paik Hospital in Korea. Subjects (n = 101) who had fallen previously were recruited through an advertisement, and 65 community-dwelling residents (11 men and 54 women) > 60 years of age who had fallen in the previous year were enrolled. All attended three educational classes that discussed falling, osteoporosis, and bone fracture; all classes were conducted by an orthopedist, a rehabilitation specialist, and a geriatrician. After participants provided written informed consent, individual interviews were conducted to determine their health and physical and functional performance. The subjects were randomized into two groups: an exercise group (EG, n = 36) and a control group (CG, n = 29) (Fig. 1). The baseline characteristics of the two groups were not significantly different with the exception of marital status; more people in the EG were married. Every 4 weeks for 12 weeks, the CG subjects were contacted by telephone or in person to collect information regarding any medical event that may have occurred. An interview and a performance evaluation were performed for all subjects at the beginning and end of the 12-week study. The nonadherence rate was

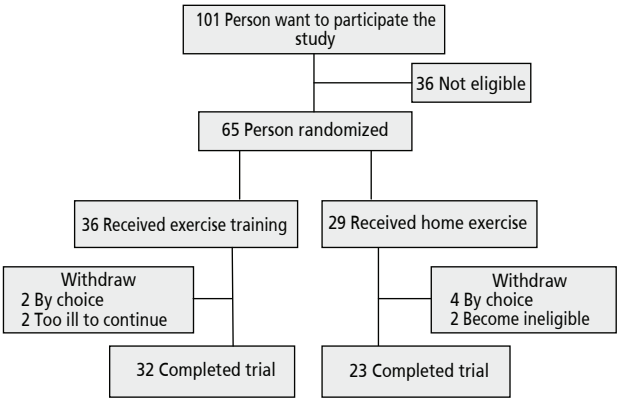

Figure 1. Flow chart showing the study protocol and the number of participants at each stage of the study.

11.1% in the EG and 20.7% in the CG. A total of 10 participants were lost before the study was completed; six were unable to attend the exercise program, two withdrew because of illness, and two withdrew to join other exercise programs (Fig. 1).

Measures

An interview was conducted to collect information about each subject's medical history, falling history, quality of life (such as the frequency of going out), and performance of activities of daily living (ADL) and to determine scores on the Short Form Health Survey (SF-8) and the Activities-specific Balance Confidence Scale-Korean version (ABC-K). Muscle strength, balance, agility, flexibility, and muscular endurance were measured as well.

The fear of falling was measured by two methods: direct questioning and use of the ABC-K scale. Each subject was asked, "How afraid are you of falling down?" The participants answered "very much afraid," "much afraid," "a little afraid," or "not at all afraid." The ABC scale [20] assesses the confidence with which one can engage in a wide range of ADL, including those performed outdoors. The participants were asked how confident they were about not losing their balance or about remaining steady when participating in 16 specific activities. The answers were rated using a scale that ranged from 0% (no confidence) to 100% (complete confidence). The ABC assesses the subject's confidence level about not falling in a wide variety of environments. For this study, we used an ABC scale that was translated into Korean (the ABC-K) for use with the study subjects and then translated back into English for reporting purposes. The ABC-K was assessed for internal consistency, and the test—retest reliability was determined.

The functional status of each subject was measured based on the degree of independence in performing five types of ADL [21] and instrumental ADL [22]. The SF-8 Health Survey is a generic, multipurpose, and short-form survey of health status with eight questionnaire items. Because our study included the SF-36 Health Survey, the SF-8 single item scales and summary measures could be scored using the same metrics as the SF-36. We used a translated SF-8 (Korean version: SF-8-K), which has been validated and undergone reliability testing [23].

To determine the strength of knee flexion, the maximal isokinetic quadriceps muscle torque was measured using an isokinetic torque machine (Cybex 770 Norm, Lumex Inc., Ronkonkoma, NY, USA). Trunk muscular strength was measured using a back strength dynamometer (T.K.K. 5102 Back-D, Takei Scientific Instruments Co., Tokyo, Japan) set at 30° of hip flexion. Balance was assessed using the Romberg test, a neurological test to detect poor balance, with the subjects' eyes closed. The Romberg test detects the inability to maintain a steady upright posture when the eyes are closed. Agility was defined as reaction time, i.e., the time between a light stimulus and the participant's response to it. Flexibility was measured using a sit-and-reach test that measures how close subjects can come to touching their toes or how far subjects can reach toward their toes while sitting on the floor and bending forward at the waist. The distance from a fingertip to an edge of a table represents the flexibility. Muscular endurance was assessed using a sit-up test in which the subject performed as many bent-knee sit-ups as possible in 30 seconds. This is a measure of abdominal and hip flexor muscular endurance.

General motor function was assessed using a 6-minute walk performance, which is significantly associated with peak oxygen uptake [24]. We used this test because the subjects' age and level of frailty prevented most of them from performing a direct assessment of maximal oxygen uptake or an assessment of submaximal oxygen uptake. For this measure, the subject walks as quickly as possible on a level course for 6 minutes.

The 12-week exercise program

The exercise program was conducted in an indoor facility, the Sports Medical Center, and was supervised by exercise specialists. The exercise program comprised 120-minute group sessions held three times a week for 12 weeks and consisted of four phases. Each session started with basic flexibility and resistance training for 40 minutes and then progressed to more difficult phases. Each phase was designed to prepare the subject for the subsequent phase.

The specialists helped the subjects perform the exercises more effectively while minimizing injury. The last phase comprised flexibility, balance, muscular strength, and endurance exercise for 80 minutes. This phase

included 10 minutes of a warm-up exercise, such as walking or stretching, 20 minutes of floor exercise for abdominal strength, 20 minutes of strength exercises for both legs, 20 minutes of balance exercise, and 10 minutes of cool-down activities.

Statistical analysis

Before and after intervention for the EG, or before and after 12 weeks' time for the CG, mean scores were calculated for strength and balance measures, and the scales that measured the fear of falling (i.e., the Fall Efficacy Scale, ABC-K, and ADL) were administered. Fear of falling was treated as a categorical variable. Comparison of values at baseline and after 12 weeks identified changes in fear of falling and in physical and functional fitness. We then analyzed differences in the main effects of exercise on the variables between the two groups. Student's *t* test and the Wilcoxon test were used to identify differences between the two groups in leg strength, abdominal strength, balance, general motor function, and ABC-K. We used logistic regression analysis to determine differences in fear of falling between the groups after the intervention, and the paired *t* test and *t* test were used to assess changes in the SF-8 scale in the EG. Pearson's correlation and partial Pearson's correlation were used to assess the associations between changes in ABC-K measurements and changes in physical and functional performance variables.

RESULTS

The baseline characteristics of the study subjects are presented in Table 1. With the exception of marital sta-

Table 1. Baseline characteristics of the 65 study participants

Baseline characteristic	Exercise group (n = 36)	Control group (n = 29)
Female	30 (83.3)	24 (82.8)
Age, yr	66.2 ± 3.2	68.7 ± 5.4
Marital status[a]	28 (77.8)	14 (48.3)
Education, yr		
6	12 (33.3)	14 (48.3)
7–12	18 (50.0)	8 (27.6)
> 12	6 (16.7)	7 (24.1)
Income, KRW (thousands)[b]		
≤ 1,000	13 (37.1)	14 (48.3)
1,000–1,999	14 (40.0)	9 (31.0)
≥ 2,000	8 (22.9)	6 (20.7)
ABC-K	62.8 ± 26.9	66.4 ± 24.9
Going outdoors, time/wk	4.7 ± 2.7	4.4 ± 2.2
ADL	17.5 ± 1.8	16.6 ± 1.8
Balance, sec	4.9 ± 3.9	3.6 ± 2.9
Agility, sec	0.5 ± 0.2	0.6 ± 0.1
Flexibility, cm	10.6 ± 8.6	9.8 ±10.0
Muscular endurance, no. of repetitions/30 sec	5.4 ± 4.8	4.2 ± 4.1
Trunk strength, kg	43.0 ± 16.9	40.1 ± 15.1
Leg strength, Nm[c]	40.8 ± 11.6	42.2 ± 16.0
6-min walk, m	413.4 ± 70.5	390.9 ± 93.1

Values are presented as number (%) or mean ± SD.

ABC-K, Activities-specific Balance Confidence Scale-Korean version; ADL, activities of daily living.

[a]$p < 0.05$ by the chi-square test.

[b]KRW is the unit of Korean currency. Suggest providing equivalent in $US.

[c]Newton-meter.

tus, there were no significant differences between the two groups in terms of demographic variables, initial fitness, fear of falling, or functional state (p = 0.019).

We hypothesized that the exercise program would reduce the fear of falling and improve the quality of life for these elderly subjects. After the intervention, the ABC-K in the EG changed by 22.7% (range, 61.1% to 83.8%), but the CG showed no significant changes in ABC-K (Table 2). Subjects in the EG showed a reduced fear of falling after they had completed the exercise program. When the subjects were asked, "How much are you afraid of falling down?" more subjects in the EG than in the CG responded "not at all" or "a little" afraid of falling down, indicating that the exercise reduced the fear of falling (p = 0.02) (Fig. 2).

The frequency of going outdoors decreased in the CG, but not in the EG, over the 12-week period (p = 0.019); however, there was no significant improvement in the quality of life (SF-8-K) in the EG. Whereas the total SF-8-K scores did not change in either group, the mean scores for the general health and mental health domains of the SF-8-K improved in the EG by 11% and 7%, respectively, compared with baseline (data not shown). It may be that the duration of exercise was not long enough to detect a change in falling frequency or in quality of life. Physical performance, including balance, muscle strength in the trunk and knees, general motor function, agility, and flexibility, were measured before and after exercise in the EG and at the start and end of the 12 weeks in the CG. The exercise program resulted in marked improvements in the EG subjects, but there was no significant improvement, and actually a slight decline, in the physical abilities of the CG subjects. The subjects in the EG showed improved walking speed, balance (p = 0.003), back strength (p = 0.08), lower extremity strength (p = 0.004), and flexibility (p < 0.001). The Romberg test, which assesses balance, showed an 86% improvement in the EG (p = 0.005). In contrast, agility and muscular endurance were not significantly different between the groups, nor were there changes over time (Table 3). It is likely that this reflects the fact that agility and muscular endurance are related to the aging process and do not improve after a relatively short-term (12-week) exercise program. Changes in balance and flexibility were associated with a reduction in the fear of falling. Changes in the ABC-K were associated only with flexibility after adjusting for age (Table 4). Leg strength was not correlated with the fear of falling. Although the 6-minute walking performance was much improved after exercise, it was not associated with changes in the ABC-K.

DISCUSSION

Fall prevention programs usually include exercises and a variety of educational and environmental management interventions. The most effective fall-prevention strategies are multifaceted interventions targeting identified risk factors that usually include muscle-strengthening exercises combined with balance training, home hazard assessment and modification by a health professional, and withdrawal of psychotropic medications [25]. Of these, exercise is the most important intervention—even more important than medical therapy—for preventing domestic accidents such as falling in the elderly [26]. Taking measures to prevent falls not only protects the elderly from physical maladies but also improves their quality of life. As shown by many previous studies, exercise can improve physical functioning in the elderly, including maintenance of balance [27-29].

Both balance [30,31] and resistance exercises [32] improve balance and reduce the frequency of falling.

Table 2. Effects of the 12-week exercise program on fear of falling, activity, and SF-8 subscales in the exercise group compared with the control group values

	Exercise group (n = 31)	Control group (n = 23)	p value[a]
Frequency of going outdoors per wk, no/wk	0.05 ± 0.34	-1.54 ± 0.52	0.010
ABC-K, %	22.66 ± 5.58	0.41 ± 4.03	0.003

Values are presented as mean ± SE.

ABC-K, Activities-specific Balance Confidence Scale-Korean version.

[a]p values are based on Wilcoxon's rank sum tests for the difference between the exercise and control groups.

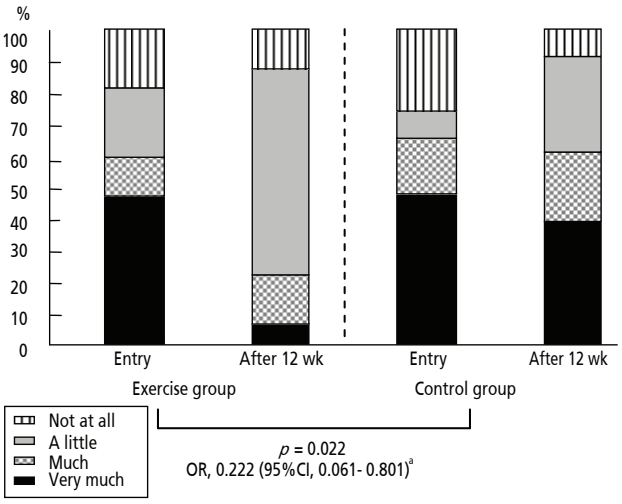

Figure 2. The effects of exercise programs on mean changes in fear of falling compared with the control group values. OR, odds ratio; CI, confidence interval. [a]Adjusted for marriage, fear of falling at baseline.

Few studies have addressed whether the fear of falling is significantly associated with overall functional performance, which is related to quality of life, especially in the elderly [29]. Accordingly, we used an intensive exercise program developed for older people with a fear of falling to investigate whether exercise improves their physical and mental health and, consequently, the quality of their lives.

The ABC-K score measured the participants' fear of falling and the effects of the intensive exercise program. Notably, the average baseline ABC-K score, which was used to measure the degree of subjects' fear of falling, was 60 before the study, which is an average score for seniors with a risk of falling. However, after the exercise program, the average EG score increased by 22.7 points, showing that the EG subjects had a more positive perception of their physical abilities. An increased fre-

Table 3. Effects of the 12-week exercise program on physical and functional performance in the exercise group and comparison with control group values

	Exercise group (n = 31)	Control group (n = 23)	*p* value[a]
Changes in balance, sec	5.84 ± 1.62	-1.05 ± 1.34	0.003
Changes in agility, sec	0.002 ± 0.031	-0.008 ± 0.036	0.834
Changes in flexibility, cm	4.14 ± 0.73	-0.09 ± 0.91	< 0.001
Changes in muscular endurance, repetitions/30 sec	2.84 ± 0.59	1.39 ± 0.86	0.159
Changes in back strength, kg	10.27 ± 3.26	1.87 ± 3.14	0.080
Changes in leg strength, Nm[b]	7.42 ± 1.98	-4.29 ± 3.11	0.004
Changes in 6-minute walk, m	42.13 ± 9.59	-28.30 ± 25.92	0.018

Values are presented as mean ± SE.

[a]*p* values are based on Student's *t* test, which was used to compare the changes in the two groups from baseline to 12 weeks later.

[b]Newton-meter.

Table 4. Correlation between changes in ABC-K scores and changes in physical and functional performance[a]

	Changes in ABC-K score	
	Unadjusted	Adjusted by age
Changes in balance	0.306[b]	0.217
Changes in flexibility	0.342[c]	0.306[d]
Changes in leg strength	0.228	0.196

ABC-K, Activities-specific Balance Confidence Scale-Korean version.

[a]The association between changes in physical and functional performance and changes in ABC-K were evaluated in the control and exercise groups after the exercise group participated in a 12-week exercise program.

[b]$p < 0.05$ by Pearson's correlation coefficient.

[c]$p < 0.05$ by Spearman's correlation coefficient.

[d]$p < 0.05$ by Pearson's partial correlation coefficient.

quency of going outdoors would be expected for subjects with improved ABC-K scores. Typically, the frequency of going outdoors in seniors decreases in the winter because of the fear of falling.

This program was conducted in the autumn and winter, so the absence of a decrease in the rate of going outdoors was itself notable. In other words, the sustained rate of outdoor activities throughout the study period indicates that the program was successful in bolstering the confidence of the participants. The increased confidence contributed to their stronger physical and mental functional performance as well, and 22% of the subjects who stated that they were "very much afraid" of falling down before the program stated that they had overcome their fears after the exercise program (Fig. 2). Other functional status measures, such as ADL measures and the SF-8-K score, did not change significantly. Because quality of life is related to emotion, cognition, comorbidity, social contacts, and other factors [33], the absence of any changes in the SF-8-K scale scores, which do not reflect these factors, was not surprising.

Muscle weakness is an important risk factor for falling [34]. Most researchers in this field believe that balance and muscle resistance training is effective for preventing falls [35]. In our study, the balance and muscular resistance exercise program was carried out for 12 weeks. The exercise was quite intense but was also simple and easy to perform. Thus, the overall drop-out rate was only 13.9%, indicating that most of the elderly participants found the program appropriate and acceptable.

Several previous studies have focused on similar issues. Another recent study investigated the effects of an exercise and education program on elderly people with a fear of falling. Despite the lack of statistical significance, the reduction in the rate of falling was consistent with that in previous fall-prevention trials [17,36] and in accordance with the results of a meta-analysis that estimated that fall prevention services reduce falls by 9% (odds ratio, 0.9; 95% confidence interval, 0.8 to 1.0) [18]. Our study revealed that an exercise program for elderly people who have a risk of falling slightly improved their physical performance but not the quality of their lives. There were minor improvements in ABC-K scores and in the fear of falling.

The American Geriatrics Society and the British Geriatric Society have updated their 2001 guidelines on preventing falls in older persons. According to the guidelines, several types of exercise can be helpful for preventing falls, including individual and group sessions, alone or in combination, that include balance exercises, strength training, flexibility exercises (muscle and joint stretching techniques), Tai Chi, and cardiovascular, endurance, and fitness training [37]. For fall-prevention programs to be successful, at least 12 weeks (one to three times per week) of prolonged exercise is required. Accordingly, we implemented a program that included three 80-minute sessions per week for 12 weeks. The intensive exercise program used here, which involved sustained exercises, had notable effects not only on physical performance but also on mental performance. Specifically, the EG subjects showed increased physical strength and a diminution in the fear of falling after completing the program. The study subjects all showed high ADL scores.

In the elderly population, exercise can prevent or slow the progression of physical disability. Even a highly functional elderly person who has fallen in the past may have a fear of falling and show a decline in physical ability [38] that leads to restrictions and impairment of ADL. Therefore, it is very important to assess the fear of falling in older individuals. Using fear of falling as a way to identify elderly people who could benefit from exercise intervention could help to improve their physical and mental performance and ultimately lead to better quality of life.

There are several limitations to this study. The study participants were relatively young, healthy elderly people (mean age, 67.3 years). There was limited participation by older elderly people (i.e., people > 75 years) because the exercise program was quite intense, involving at least 12 weeks of prolonged exercise. In earlier studies, we found that falls and fall-related injury rates increase with age [39]. Future studies should consider whether the age at which participants begin the exercise program influences the fall rate. It would also be helpful to determine the benefits and risk of this exercise program for different age groups. Another limitation of this study is the fact that because of the relatively short study period, this study could not determine whether the number of falls experienced by a subject in the past affected the outcome of the exercise program. We plan

to perform another study with a longer research period in the near future to address this issue.

In conclusion, Fear of falling is a major health problem among community-living older people. This study showed that a 12-week exercise program improved balance, flexibility, and muscle strength in subjects > 60 years of age who had fallen in the past year and feared falling again. These findings support the idea that balance and resistance exercises can reduce the fear of falling and improve the quality of life for elderly people.

Conflict of interest

No potential conflict of interest relevant to this article is reported.

Acknowledgments

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