Effectiveness of a Fall Prevention Exercise Program on Falls Risk in Community-Dwelling Older Adults

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ABSTRACT

Purpose: Multimodal exercise programs improve functional capacity in older adults, but no progressive multimodal group exercise model that reduces fall risk has been detailed. In addition, research indicates that basic exercise programs can be led by peer exercise leaders with no formal fitness education, yet it is unknown whether a complex exercise program design would result in similar positive outcomes. The purposes of this study were 1) to determine the effect of a progressive multimodal 12-wk exercise program on falls risk, balance confidence, and perceptions of health and 2) to assess the effectiveness of the program when delivered by older lay exercise leaders. **Methods:** 1) Community-dwelling older adults (N = 95) were recruited and participated in a 12-wk multimodal progressive exercise program consisting of exercises for joint mobility, sensory stimulation, muscle strength/power, balance, and gait enhancement. The Functional Reach Test, Timed Up-And-Go Test, 30-s Chair Stand Test, Activities Specific Balance Confidence Scale, and 12-item Short Form Health Outcomes Survey were collected at baseline and completion. 2) The same intervention was delivered to a randomized group of older adults assigned to lay exercise leaders (N = 23), certified fitness leaders (N = 24), or a control group (N = 23). **Results:** 1) The program significantly reduced falls risk and improved balance confidence and perceptions of health. 2) Both exercise lay leader and certified leader classes resulted in a significant reduction in falls risk compared with the control group. **Conclusion:** This 12-wk progressive multimodal exercise program was effective at reducing falls risk and may be adaptable to other settings.

INTRODUCTION

More than 33% of older Americans sustain at least one fall annually. Falls can have a devastating effect on the well-being of older adults and are the age group's leading cause of injury deaths and the most common cause of nonfatal injuries and hospital admissions for trauma. In addition, falls also result in significant medical costs. The Centers for Disease Control and Prevention reports that $31 billion is spent annually via Medicare on direct care for injuries resulting from a fall (1).

The high incidence and medical costs of falls among older adults have led to many efforts to reduce falls risk. It was recognized in the early 1990s that falls occur at least in part because of physical deficits in balance, strength, reaction time, and flexibility (2).

More recently, in a meta-analysis of exercise interventions aimed at reducing falls in older adults, Gillespie and colleagues (3) found that exercise classes containing multiple components (i.e., balance, strength training) exhibited a significant reduction in the relative risk (RR) of falls (RR, 0.78; 95% confidence interval, 0.71–0.86) as well as the risk of falling (RR, 0.83; 95% confidence interval, 0.72–0.97). However, not all interventions are of sufficient duration to result in a reduction of falls occurrence. Sherrington et al. (4) reported that at least 50 h of exercise training is needed to be completed to see a reduction in falls occurrence, whereas shorter interventions may still be successful in improving functional outcomes that reduce falls risk such as muscle strength, dynamic and static balance, flexibility, and gait (5,6). It has also been found that interventions to reduce falls or falls risk are most successful when the participants are older and have either sustained recent falls or are determined to be at a high risk of falls due to compromised physical function (7–10).

In addition to physical performance factors, one's balance confidence is an important consideration in determining an older adult's quality of life. Balance confidence has been shown to be negatively affected by falls occurrence and has a role in reduced activity among older adults (11), but exercise interventions have been shown to improve balance confidence in older adults (12,13), which has a positive association with physical factors associated with falls risk and independence, such as gait (14).

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Exercise interventions for falls risk reduction vary considerably in their programmatic components and progression schemes. Exercises for lower body strength, trunk muscle strength (15), static and dynamic balance, visual and vestibular stimulation (16,17), and gait enhancement have all shown promise. It is now important to develop these components into a systematic, progressive exercise program model that can be adapted to different situations and/or populations because there still exists a lack of consensus on frequency and dose of exercise necessary to reduce falls risk (18).

Systematic exercise progression models for older adults have been shown to be effective in other types of exercise programs (15,19–21). More specifically, research utilizing progressive training or periodization schemes in older adults have improved appendicular muscle strength (19–21), trunk muscle strength (15), lean body mass (22), static and dynamic balance (15,20), gait speed (19,21), and aerobic capacity (20). In addition, a similar training program improved older adult sport performance (23). However, the literature has yet to detail a systematically progressed multidimensional training program for reducing falls risk.

The importance of these programmatic components lies in their connection to the incidence of falls. Primary factors related to increased fall risk in older adults include reduction in the following intrinsic neurophysiological mechanisms: muscular performance of lower extremities (24,25), posture and postural control (24), dynamic balance, and gait speed (24,26).

Thus, the purpose of our first study was to determine the effectiveness of a 12-wk progressive, multidimensional exercise program on reducing falls risk and improving balance confidence in community-dwelling older adults who had sustained an accidental fall in the past 6 months. It was hypothesized that participants who successfully completed the program would improve functional capacity and balance confidence.

A secondary purpose of this study was to determine the effect of exercise leadership experience on participant outcomes. A primary objective of community-based exercise programs must be long-term sustainability. However, most falls prevention exercise interventions in the literature have been led by research team members, licensed clinicians, and/or certified fitness professionals. A recent study by Shubert and colleagues (27) demonstrated that the evidence-based Otago Fall Prevention Program could successfully be delivered in a community-based setting with occupational therapy assistants and certified fitness professionals leading the program instead of licensed physical therapists. However, sustainability may be an issue because a program may have little chance of continuation after the conclusion of the formal research period. Community-based senior centers and recreation facilities often have limited funding and mostly serve seniors on fixed incomes making a fee-for-service model problematic. Thus, a training program that can be led by community volunteers may ensure long-term program sustainability. Dorgo and colleagues (28,29) have studied the effectiveness of lay exercise leaders and found that lay exercise leaders are effective in improving fitness and quality of life outcomes and retaining older adults in exercise programs. A lay exercise leader is an individual who does not have any clinical training or fitness certification. However, these individuals can be prepared to lead an exercise class through formal or informal training by qualified professionals and/or current exercise leaders. In addition, a recent analysis of a peer-led exercise program (SAYGO trial) demonstrated that injurious falls can be decreased by having older adults lead exercise classes to their peers (30).

However, delivery of a complex progressive, multimodal exercise program to reduce falls risk may make a lay leadership model less effective. Falls prevention programs are most successful when they include several different intervention strategies including exercises for joint mobility, sensory stimulation, muscle strength, static balance, dynamic balance, and gait enhancement (31). Each of these domains of exercise requires different movement skills and an overall understanding of the interaction of these different exercise components in reducing the risk for falls. In addition, exercise programs should include progressions of exercise volume and exercise complexity every 4–6 wk to ensure maximal benefit and improvement in physical capacity (32,33). Therefore, a 12-wk intervention should have 2–3 programmatic modifications throughout the course of the training program. The delivery of this level of a program may be problematic for lay exercise leaders and reveal a difference in the outcomes of the intervention depending on the qualifications and experience of the exercise leader.

Thus, the purpose of our second study was to determine if peer volunteer exercise leaders from the community could effectively lead the 12-wk falls prevention exercise program. These exercise leaders were at least 60 yr old and had no background in clinical or fitness fields. It was hypothesized that community-based volunteers could successfully lead the program and there would be no statistical differences in participant outcomes as compared with participants led by certified fitness professionals.

METHODS

Study 1: 12-wk Program Efficacy

Subjects and Recruitment

Potential participants responded to flyers posted at community senior centers and were interviewed by telephone before a 30-min screening appointment. To qualify for the study, participants needed to have sustained an accidental fall in the past 6 months. An accidental fall was defined previously as an occurrence where the person comes to rest on the ground, floor, or any other lower surface and was not caused by a seizure, loss of consciousness, or a violent blow. Falls were required to have occurred during activities associated with everyday living (e.g., walking and gardening) to ensure that participants were representative of a majority of community-dwelling older adults. Exclusion criteria included persons who were younger than 65 yr, diagnosed with progressive neurological conditions or uncontrolled metabolic and/or heart disease, or were not available for the period of the study. Participants were asked to maintain their current activity level and to not add any new physical activities other than this intervention during the study period. In addition, all participants were required to obtain physician consent before the start of the exercise program. A total of 256 potential participants inquired about the study, 115 participants qualified for the study and were enrolled, and 95 completed at least 20 of 24 (83%) exercise sessions. These 95 participants were included in the final data analysis. Descriptive statistics for these participants are contained in Table 1.

All participants voluntarily signed informed consent, and the study protocol was approved by the Institutional review board of the University of San Francisco.

An 83% class adherence criterion was chosen for this study to ensure that a sufficient dose of the prescribed exercise program was received. In previous studies, participant adherence to the

TABLE 1.
Descriptive Statistics of Study 1 Participants.

	N	Mean ± SD	Minimum	Maximum
Age, yr	95	78.22 ± 6.96	60.00	92.00
Height, inches	95	64.48 ± 3.89	55.50	74.50
Weight, lb	95	158.51 ± 33.74	99.00	249.00
Classes attended	95	21.59 ± 2.11	20.00	24.00

prescribed exercise intervention has varied widely, and results have been difficult to interpret (7,34).

Assessments

At baseline and at the completion of the 12-wk program, all participants were measured on the following validated assessments of functional performance in older adults: Functional Reach Test (FRT), Timed Up-And-Go Test (TUG), and 30-s Chair Stand Test (CS). These assessments are commonly used in the literature to evaluate changes in functional capacity in older adults (35–37). Assessments were performed by a trained gerokinesiologist with more than 20 yr of experience in the field. Assessments were performed in a multipurpose room with adequate space and lighting. Three practice trials on the dominant arm were done for the FRT followed by three independent measurement trials. Measurement was made to the closest 0.25″. The average of the three trials was calculated and used in data analysis. One practice trial of the TUG was performed followed by two independent measurement trials. Measurement was made to the closest 0.01 s, and the best of the two trials was used in data analysis. One practice trial of the CS was performed followed by a single full trial. Total repetitions were used in data analysis. Subsequently, the participant sat at a table and completed the 16-item Activity-Specific Balance Confidence Scale (ABC) and the 12-item Short Form Health Outcomes Survey (SF-12). Research staff were on hand to provide clarification to any questions to ensure completeness. Score for the ABC was the summed score divided by 16. A physical composite score (PCS) and mental composite score (MCS) were calculated from SF-12 questionnaire results using licensed scoring software.

Description of Intervention

Eight offerings of a 12-wk progressive, multidimensional exercise program were delivered at two different senior centers over a 16-month period. Each program offering enrolled no more than 15 participants and was led by the lead researcher, a trained and certified gerokinesiologist with more than 20 yr of experience in the field. There were two 60-min sessions per week and each exercise session included a 10-min warm-up consisting of dynamic mobility exercises for the ankle, hip, spine, and shoulders; a 5-min sensory integration period consisting of exercises for visual and vestibular stimulation; a 15-min strength training period involving exercises for both the lower body and upper body using dumbbells and resistance bands; a 20-min dynamic balance and gait enhancement period involving reaching and stepping exercises; and a 10-min cool down. The program progressed in exercise volume on a biweekly basis and progressed in exercise complexity every 4 wk to accommodate the anticipated improvements in functional capacity of the participants (32). The exercise program design is detailed in Supplemental Digital Content 1 (see Table, Supplemental Digital Content 1, 12-wk exercise program design, http://links.lww.com/TJACSM/A29) and Supplemental Digital Content 2 (see Video, Supplemental Digital Content 2, abbreviated class session, http://links.lww.com/TJACSM/A30). Any participant having difficulty with the rate of program progression was supervised closely and recommended to perform a more regressed form of the exercise.

Statistical Analysis

Means ± SD were calculated for all dependent variables. Dependent-samples *t*-tests were performed to determine differences in variables of interest.

Study 2: Exercise Leadership Experience

To assess the effectiveness of lay exercise leaders delivering this intervention, a second recruitment of 60 participants were randomly assigned to a lay leader group (LAY; $N = 30$) or a certified fitness professional (FIT) ($N = 30$) group. Of these participants, 47 participants completed at least 20 of 24 exercise sessions (LAY, 23; FIT, 24). FIT included 19 women and 5 men, and LAY included 20 women and 3 men. Adherence to the program was good and was not significantly different between the LAY and FIT groups. A waitlist of participants maintaining current levels of physical activity constituted a control group (CON; $N = 23$). Participants in CON included 18 women and 5 men. These participants were offered to receive the training program at the conclusion of the research study. Descriptive statistics for these participants are contained in Table 2.

Assessments were replicated for the study following the same protocols outlined earlier. Four offerings of the same 12-wk program as described previously were delivered at two different senior centers. Participant recruitment strategies were replicated from the earlier intervention. Four exercise leaders (2 FIT and 2 LAY) were recruited to each lead one 12-wk program offering. The order of program offerings was randomized, and participants were blinded as to the qualifications of their program leader. Potential leaders responded to flyers posted at local fitness and recreation facilities. The FIT leaders were certified fitness professionals with at least 5-yr experience in the fitness industry as personal trainers and/or group exercise instructors. The LAY leaders had no formal exercise leadership experience. Characteristics of the LAY leaders were based on previous research and included good health status, desire to lead exercise, positive personality traits, and commitment to the program (28,29). Both FIT and LAY exercise leaders attended a 1-h training session on the implementation of the 12-wk exercise protocol and were provided with a manual that included descriptions and photographs of each exercise along with sets, repetitions, and duration for each exercise session. LAY exercise leaders met with research staff for four separate 1-h meetings before the intervention to discuss relevant topics such as participant safety, exercise adherence, participant motivation, cueing strategies, physiological adaptations, and common musculoskeletal issues with aging. LAY leaders were trained via text materials and practical simulations during these meetings. Some specific content covered included how to identify the difference between

TABLE 2.
Descriptive Statistics of Study 2 Participants.

	N	Mean ± SD	Minimum	Maximum
Expert				
Age, yr	24	78.75 ± 5.86	67.00	89.00
Height, inches	24	64.61 ± 4.34	58.50	74.50
Weight, lb	24	157.54 ± 34.91	99.00	240.00
Classes attended	24	21.88 ± 5.86	16.00	24.00
Volunteer				
Age, yr	23	77.39 ± 7.04	67.00	92.00
Height, inches	23	64.23 ± 3.61	59.50	70.00
Weight, lb	23	155.3 ± 40.07	100.00	249.00
Classes attended	23	21.7 ± 2.01	18.00	24.00
Control				
Age, yr	23	76.52 ± 5.45	69.00	87.00
Height, inches	23	64.87 ± 3.05	60.00	70.00
Weight, lb	23	152.35 ± 29.35	103.00	208.00
Classes attended	23	0 ± 0	0	0

muscle fatigue and joint pain and how to identify symptoms of cardiovascular and metabolic emergencies. In addition, LAY leaders practiced participant cueing and feedback strategies using verbal, visual, and tactile methods to correct improper exercise form. LAY leaders were also taught to use open-ended questions to encourage class participants to share success stories with their classmates as the program progressed over time. Program fidelity was monitored in all FIT and LAY program offerings. Research staff assessed program fidelity through the use of observation checklists to ensure that the program was being delivered according to the program design.

Statistical Analysis

Means ± SD were calculated for all dependent variables. ANCOVA was performed to determine differences in change scores between groups in variables of interest in study 2. Pretest scores were used as the covariate to adjust for baseline effects of the measure. Tukey *post hoc* tests were done to determine significance.

RESULTS

Study 1: 12-wk Program Efficacy

Descriptive statistics for all dependent variables are displayed in Table 3. The dependent *t*-test comparing FRT distance revealed a significant increase from baseline to follow-up ($P < 0.0001$). In addition, the dependent *t*-test comparing TUG time revealed a significant decrease from baseline to follow-up ($P = 0.0123$). Finally, the dependent *t*-test comparing CS repetitions revealed a significant increase from baseline to follow-up ($P < 0.0001$).

Analysis of the surveys used in the study indicated that balance confidence as measured by the mean score of items on the ABC questionnaire significantly increased from baseline to

TABLE 3.
Descriptive Statistics for All Dependent Variables of Study 1.

	N	Pre, Mean ± SD	Post, Mean ± SD	Change, Mean ± SD
FRT, inches	95	8.76 ± 2.58	11.14 ± 3.42	2.38 ± 3.51**
TUG, s	95	12.16 ± 10.18	10.00 ± 3.94	−2.16 ± 8.27*
CS, reps	95	9.38 ± 4.04	12.35 ± 5.06	2.97 ± 3.53**
ABC questionnaire score	91	65.89 ± 16.90	73.11 ± 16.13	7.22 ± 13.96**
SF-12 MCS	89	49.78 ± 9.93	52.22 ± 9.75	2.44 ± 8.73**
SF-12 PCS	89	40.55 ± 9.23	43.90 ± 8.45	3.35 ± 8.27**

*Significantly different from pretesting to posttesting, $P < 0.05$.
**Significantly different from pretesting to posttesting, $P < 0.01$.

follow-up ($P < 0.0001$). Meanwhile, SF-12 scores for both the PCS ($P = 0.0002$) and MCS ($P = 0.009$) significantly improved from baseline to follow-up.

Study 2: Exercise Leadership Experience

Descriptive statistics for all groups and all dependent variables are displayed in Table 4. ANCOVA revealed that FRT distance significantly improved in FIT versus LAY, and both FIT and LAY improved significantly as compared with CON. In addition, ANCOVA determined that TUG improved significantly in LAY versus CON, but there was no significant difference in improvement in FIT versus CON or FIT versus LAY. Finally, ANCOVA revealed that CS performance significantly improved in FIT and LAY versus CON, and there was no significant difference in improvement FIT versus LAY.

Analysis of the surveys used in the study indicated no significant difference in the improvement in balance confidence as measured by the ABC questionnaire between FIT, LAY, and CON. Meanwhile, SF-12's MCS improved significantly in FIT and LAY versus CON, and there was no significant difference in FIT versus LAY. Finally, SF-12 PCS improvement did not differ significantly between the FIT, LAY, and CON groups.

DISCUSSION

Study 1: 12-wk Program Efficacy

This 12-wk progressive exercise program was found to be effective in improving functional capacity and balance confidence in community-dwelling older adults who had sustained a recent accidental fall. The improvement seen in the functional fitness assessments is consistent with many other interventions (15,20,38). In their systematic review, Liu and Latham (20) concluded that progressive resistance training (PRT) can improve physical function in older adults, which includes reducing physical disability and functional limitations such as balance, CS, TUG, and muscle weakness.

The progressive multicomponent exercise program used for this study was designed to incorporate movements that addressed age-related functional performance deficits known to be associated with incidence of falls (24) as well as activities of daily living (ADL). This included both bilateral and unilateral bodyweight and resisted movements, multidimensional movements, and sensory

TABLE 4.
Descriptive Statistics for All Dependent Variables of Study 2.

	Pre, Mean ± SD	Post, Mean ± SD	Change, Mean ± SD
Expert (n = 24)			
FRT, inches	8.57 ± 2.90	11.60 ± 2.32	3.03 ± 2.54*,**
TUG, s	10.30 ± 2.07	9.63 ± 2.31	−0.067 ± 1.50
CS, reps	10.29 ± 2.91	13.25 ± 3.61	2.96 ± 2.53*
ABC questionnaire score	67.50 ± 16.34	75.63 ± 13.77	8.13 ± 14.27
SF-12 MCS	47.79 ± 8.90	52.49 ± 8.66	4.70 ± 6.16
SF-12 PCS	44.37 ± 6.06	45.41 ± 8.54	1.04 ± 6.92*
Volunteer (n = 23)			
FRT, inches	9.11 ± 2.43	10.63 ± 2.19	1.52 ± 1.63*
TUG, s	12.04 ± 4.58	10.52 ± 4.42	−1.52 ± 2.00*
CS, reps	7.96 ± 4.13	10.61 ± 5.19	2.65 ± 2.84*
ABC questionnaire score	68.53 ± 17.95	71.98 ± 17.00	3.45 ± 11.78
SF-12 MCS	49.87 ± 10.10	53.01 ± 9.61	3.14 ± 6.03
SF-12 PCS	40.57 ± 10.25	43.91 ± 8.70	3.34 ± 10.26*
Control (n = 23)			
FRT, inches	8.85 ± 2.80	8.96 ± 2.85	0.11 ± 0.95
TUG, s	11.02 ± 3.65	11.18 ± 3.39	0.16 ± 0.91
CS, reps	8.09 ± 3.37	7.96 ± 3.32	−0.13 ± 1.84
ABC questionnaire score	71.50 ± 14.43	76.50 ± 12.40	5.00 ± 15.04
SF-12 MCS	49.07 ± 6.33	48.92 ± 6.51	−0.15 ± 1.87
SF-12 PCS	46.49 ± 4.87	46.16 ± 5.10	−0.33 ± 1.87

*Significantly different from pretesting to posttesting than control, $P < 0.05$.
**Significantly different from pretesting to posttesting than volunteer, $P < 0.05$.

enriched motions (vestibular, visual, and somatosensory). The goal was to structure exercises that progressively provided an integrated effect for flexibility, mobility, strength, and balance. The results of this study showed that this multicomponent model was effective for significantly enhancing the functional performance measures FRT, TUG, and CS. These findings are consistent with previous research (19,20,39). In their recent systematic reviews of the effects of PRT on the functional performance of older adults, Latham et al. (19) and Liu and Latham (20) both showed that PRT had a moderate to high beneficial effect on CS. Liu and Latham (20) further showed that PRT was significantly beneficial for the TUG. Sousa and Sampaio (39) in a randomized control trial showed PRT to significantly increased FRT in their experimental group when compared with controls.

Although the physical assessments used in this study (FRT, TUG, and CS) are predominantly sagittal plane motions, the unilateral arm reach (FRT) and the gait and turning aspects of TUG also place mechanical stress on the lateral and rotatory planes of motions. This requires posterior muscular strength to decelerate and control anterior lean both statically (FRT and CS) and dynamically (TUG) and further requires lateral and rotational muscle strength (40) that is often seen in ADL. Recent research has shown a significant association between decreased trunk extensor muscle strength and falls (41). Furthermore, in a randomized control trial, Hosseini and colleagues (6) showed significant increases in both balance and gait in a core stabilization training group when compared with a strength training–only group and a control group. In a recent systematic review, Granacher and colleagues (15) concluded that strength of the core musculature is important for the successful performance of ADL by contributing to more efficient use of the lower and upper extremities, and improved balance/functional performance. Our program targeted the trunk extensor and abdominal muscles with many exercises by utilizing stepping and squatting with bilateral, reciprocating, and unilateral upper body motions.

This exercise program design with systematic increases in both exercise volume and complexity over a 12-wk period provides a model that can be adapted to be suitable for older adults in a variety of different settings (e.g., skilled nursing facilities, assisted living housing, masters athletes, etc.) through appropriate exercise regression/progression strategies that have been described previously (21,32). In fact, this program design was adapted from a study by Thompson and colleagues (23) investigating the effects of an 8-wk multimodal functional training program on fitness and golf performance in older men. That exercise program had systematic increases in exercise complexity and volume over an 8-wk period and included exercises for core stability, muscle strength, balance, flexibility, and rotational power to reflect the task demands of golf. The results of that study demonstrated that the training program improved both functional fitness and golf performance. Although the research subjects differed substantially between that training study and the present investigation and the aims of the studies were also quite different, the exercise program design framework was similar. Both studies included several different types of exercises performed to meet the variable task demands of the outcome of interest (i.e., golf performance or falls risk reduction), and the progression of the exercise programs increased exercise volume and complexity over time. Similar to this study, practitioners should consider various progression strategies beyond simply increasing sets or repetitions. Progressing standing exercises from wide stance to narrow stance to single-leg stance provides increasing challenge to postural control, as does upper body progressions from bilateral to unilateral loading. Sensory stimulation and static balance exercises can be progressed from stable surfaces to more unstable surfaces. Dynamic balance exercises can be progressed from slow and small movements to larger and faster movements. Future research should continue to apply a similar progression approach to exercise program design with other samples of older adults such as institutionalized older adults or masters athletes.

The significant improvement in balance confidence seen in this study may be due to the instructors regularly providing verbal positive reinforcement and correlated exercises done during the class to real-world environments (e.g., explaining that gait ladder patterns would allow participants to successfully modify their movement strategies in locations such as a crowded sidewalk). In addition, for the final 6 wk of the program, there was a formal time period during the cool-down of each class where participants were encouraged to share success stories that illustrated the positive effects of the program in their lives.

These results may also play a role in the improvements in measures of physical and mental well-being associated with the SF-12 quality of life questionnaire because of the close association between physical health and other domains of wellness in older adults.

Study 2: Exercise Leadership Experience

Participants in the LAY group made significant improvements in all assessments of functional fitness versus the CON group, and participants in the FIT group significantly improved in FRT and CS versus the CON group. These results support the findings of our previous results, demonstrating the efficacy of this 12-wk intervention program in reducing falls risk in older adults who had recently sustained an accidental fall. It is also apparent that the effectiveness of the exercise program design is more important than exercise leadership experience in determining the success of an intervention. Only the FRT results showed a significantly greater improvement in performance in FIT versus LAY participants.

These findings support previous research by Dorgo et al. (28,29) and Wurzer et al. (30) that found that appropriately selected older adult community volunteers who received basic training in exercise leadership and safety can lead exercise programs for older adults. However, the current exercise intervention was markedly more complex than previous interventions, using a periodized progressive design including a variety of exercises for joint mobility, sensory stimulation, muscle strength, static balance, dynamic balance, and gait enhancement. Despite this, our LAY group leaders delivered the program effectively. This finding indicates that even a complex multimodal exercise program can be both successful and sustainable in the community when recruiting community volunteers to lead them with some basic preparatory training before the program being initiated.

The findings of self-reported mental and physical quality of life and balance confidence were mixed. Previously, Dorgo et al. (28) demonstrated that peer-mentored exercise program participants reported a greater sense of mental and physical well-being as compared with participants trained by young undergraduate students. This finding was in spite of a similar improvement in physical function outcomes in both groups. In our study, mental well-being composite score on the SF-12 questionnaire significantly improved in both the LAY and FIT groups versus the CON group, but there were no differences between the LAY and FIT groups. This may be attributable to the similarity in ages of the exercise leaders in this study. The LAY leaders were 63 and 67 yr old, whereas the FIT leaders were 60 and 64 yr old. Thus, the selection of age-group peers as exercise leaders can improve perceptions of mental well-being despite differing backgrounds of the LAY and FIT leaders. Interestingly, physical well-being composite scores did not significantly improve in any of the three groups, despite the improvements in functional fitness in the LAY and FIT groups. In addition, unlike our other intervention reported here, balance confidence did not significantly improve in any of the three groups despite the same approach to connect exercises with daily activities and encouraging participants to share success stories with their classmates. It is unknown whether other factors played a role in this or if it could have been due to a small sample size as compared with the first intervention.

Thus, these two interventions demonstrate that reduction in falls risk can be achieved by applying a 12-wk multimodal progressive exercise program design. It seems that appropriately selected lay older exercise leaders with basic preparation on exercise leadership and safety, such as understanding how and when to deliver verbal, visual, and tactile cueing/feedback, are as effective in leading this program as certified fitness professionals. There are limitations to this study. It is uncertain whether the exercise program design and progressions detailed in the Appendix would be optimal for delivery in a clinical setting to individual patients. Therefore, it is recommended that this model be evaluated on a case-by-case basis to determine if the enlisted progression strategies should be modified for differing levels of function. The program design also has not been adapted to other settings; therefore, it is suggested that future research use a similar exercise program design and choose exercises that can be adapted to be suitable for older adults in a variety of different settings (e.g., outpatient rehabilitation settings, skilled nursing facilities, masters athletes, etc.) through appropriate exercise regression/progression strategies described earlier.

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REFERENCES

1. Burns ER, Stevens JA, Lee R. The direct costs of fatal and non-fatal falls among older adults—United States. *J Safety Res*. 2016;58:99–103. doi: 10.1016/j.jsr.2016.05.001.
2. Tinetti ME, Speechley M. Prevention of falls among the elderly. *N Engl J Med*. 1989;320(16):1055–9.
3. Gillespie LD, Robertson MC, Gillespie WJ, et al. Interventions for preventing falls in older people living in the community. *Cochrane Database Syst Rev*. 2012;(9):CD007146.
4. Sherrington C, Tiedemann A, Fairhall N, Close JC, Lord SR. Exercise to prevent falls in older adults: an updated meta-analysis and best practice recommendations. *N S W Public Health Bull*. 2011;22(3–4):78–83.
5. Freiberger E, Menz HB, Abu-Omar K, Rutten A. Preventing falls in physically active community-dwelling older people: a comparison of two intervention techniques. *Gerontology*. 2007;53(5):298–305.
6. Hosseini SS, Asl AK, Rostamkhany H. The effect of strength and core stabilization training on physical fitness factors among elderly people. *World Appl Sci J*. 2012;16(4):479–84.
7. Barnett A, Smith B, Lord SR, Williams M, Baumand A. Community-based group exercise improves balance and reduces falls in at-risk older people: a randomised controlled trial. *Age Ageing*. 2003;32(4):407–14.
8. Carter ND, Khan KM, McKay HA, et al. Community-based exercise program reduces risk factors for falls in 65- to 75-year-old women with osteoporosis: randomized controlled trial. *CMAJ*. 2002;167(9):997–1004.
9. Rubenstein LZ, Josephson KR, Trueblood PR, et al. Effects of a group exercise program on strength, mobility, and falls among fall-prone elderly men. *J Gerontol A Biol Sci Med Sci*. 2000;55(6):M317–21.
10. Shumway-Cook A, Silver IF, LeMier M, York S, Cummings P, Koepsell TD. Effectiveness of a community-based multifactorial intervention on falls and fall risk factors in community-living older adults: a randomized, controlled trial. *J Gerontol A Biol Sci Med Sci*. 2007;62(12):1420–7.
11. Lee F, Mackenzie L, James C. Perceptions of older people living in the community about their fear of falling. *Disabil Rehabil*. 2008;30(23):1803–11. doi: 10.1080/09638280701669508.
12. Bergland A, Pettersen AM, Laake K. Functional status among elderly Norwegian fallers living at home. *Physiother Res Int*. 2000;5(1):33–45.
13. Wurzer B, Waters DL, Hale LA. Fall-related injuries in a cohort of community-dwelling older adults attending peer-led fall prevention exercise classes. *J Geriatr Phys Ther*. 2016;39(3):110–6.
14. Rochat S, Büla CJ, Martin E, et al. What is the relationship between fear of falling and gait in well-functioning older persons aged 65 to 70 years? *Arch Phys Med Rehabil*. 2010;91(6):879–84.
15. Granacher U, Gollhofer A, Hortobágyi T, Kressig RW, Muehlbauer T. The importance of trunk muscle strength for balance, functional performance, and fall prevention in seniors: a systematic review. *Sports Med*. 2013;43(7):627–41.
16. Logghe IH, Verhagen AP, Rademaker AC, et al. The effects of tai chi on fall prevention, fear of falling and balance in older people: a meta-analysis. *Prev Med*. 2010;51(3–4):222–7.
17. Reed-Jones RJ, Dorgo S, Hitchings MK, Bader JO. Vision and agility training in community dwelling older adults: incorporating visual training into programs for fall prevention. *Gait Posture*. 2012;35(4):585–9.
18. Shubert TE. Evidence-based exercise prescription for balance and falls prevention: a current review of the literature. *J Geriatr Phys Ther*. 2011;34(3):100–8.
19. Latham NK, Bennett DA, Stretton CM, Anderson CS. Systematic review of progressive resistance strength training in older adults. *J Gerontol A Biol Sci Med Sci*. 2004;59(1):48–61.
20. Liu CJ, Latham NK. Progressive resistance strength training for improving physical function in older adults. *Cochrane Database Syst Rev*. 2009;3:CD002759.
21. Strohacker K, Fazzino D, Breslin WL, Xu X. The use of periodization in exercise prescriptions for inactive adults: a systematic review. *Prev Med Rep*. 2015;2:385–96.
22. Botero JP, Shiguemoto GE, Prestes J, et al. Effects of long-term periodized resistance training on body composition, leptin, resistin and muscle strength in elderly post-menopausal women. *J Sports Med Phys Fitness*. 2013;53(3):289–94.
23. Thompson CJ, Cobb KM, Blackwell J. Functional training improves club head speed and functional fitness in older golfers. *J Strength Cond Res*. 2007;21(1):131–7.
24. Carter ND, Kannus P, Khan KM. Exercise in the prevention of falls in older people: a systematic literature review examining the rationale and the evidence. *Sports Med*. 2001;31(6):427–38.
25. Kerrigan DC, Todd MK, Della Croce U, Lipsitz LA, Collins JJ. Biomechanical gait alterations independent of speed in the healthy elderly: evidence for specific limiting impairments. *Arch Phys Med Rehabil*. 1998;79(3):317–22.
26. Himann JE, Cunningham DA, Rechnitzer PA, Paterson DH. Age-related changes in speed of walking. *Med Sci Sports Exerc*. 1988;20(2):161–6.
27. Shubert TE, Smith ML, Goto L, Jiang L, Ory MG. Otago exercise program in the United States: comparison of 2 implementation models. *Phys Ther*. 2017;97(2):187–97.
28. Dorgo S, King GA, Bader JO, Limon JS. Comparing the effectiveness of peer mentoring and student mentoring in a 35-week fitness program for older adults. *Arch Gerontol Geriatr*. 2011;52(3):344–9.
29. Dorgo S, King GA, Bader JO, Limon JS. Outcomes of a peer mentor implemented fitness program in older adults: a quasi-randomized controlled trial. *Int J Nurs Stud*. 2013;50(9):1156–65.
30. Wurzer B, Waters DL, Hale LA. Fall-related injuries in a cohort of community-dwelling older adults attending peer-led fall prevention exercise classes. *J Geriatr Phys Ther*. 2016;39(3):110–6.
31. Rose D. *Fallproof. A Comprehensive Balance and Mobility Program*. 2nd ed. Champaign (IL): Human Kinetics; 2010.
32. Haff GG, Nimphius S. Training principles for power. *Strength Cond J*. 2012;34(6):2–12.
33. Kraemer WJ, Adams K, Cafarelli E, et al. American College of Sports Medicine Position Stand. Progression models in resistance training for healthy adults. *Med Sci Sports Exerc*. 2002;34(2):364–80.
34. Barnett A, Smith B, Lord SR, Williams M, Baumand A. Community-based group exercise improves balance and reduces falls in at-risk older people: a randomised controlled trial. *Age Ageing*. 2003;32(4):407–14.
35. Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. *J Gerontol*. 1990;45(6):M192–7.
36. Jones CJ, Rikli RE, Beam WC. A 30-s chair-stand test as a measure of lower body strength in community-residing older adults. *Res Q Exerc Sport*. 1999;70(2):113–9.
37. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Phys Ther*. 2000;80(9):896–903.
38. Baker MK, Atlantis E, Fiatarone Singh MA. Multi-modal exercise programs for older adults. *Age Ageing*. 2007;36(4):375–81.
39. Sousa N, Sampaio J. Effects of progressive strength training on the performance of the Functional Reach Test and the Timed Get-Up-and-Go Test in an elderly population from the rural north of Portugal. *Am J Hum Biol*. 2005;17(6):746–51.
40. Neumann D. *Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation*. St. Louis: Mosby; 2002.
41. Kasukawa Y, Miyakoshi N, Hongo M, et al. Relationships between falls, spinal curvature, spinal mobility and back extensor strength in elderly people. *J Bone Miner Metab*. 2010;28(1):82–7.