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ORIGINAL RESEARCH

Randomized Controlled Trial of Screening, Risk Modification, and Physical Therapy to Prevent Falls Among the Elderly Recently Discharged From the Emergency Department to the Community: The Steps to Avoid Falls in the Elderly Study

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Abstract

Objective: To evaluate the effectiveness of a multifactorial, tailored program of physical therapy to reduce the occurrence of falls among a heterogeneous group of high-risk elderly Singaporeans recently discharged from the emergency department (ED).

Design: Randomized controlled trial.

Setting: Communities.

Participants: Adults (N=354) aged ≥65 years who were seen in the ED for a fall or fall-related injuries and discharged home.

Interventions: The intervention primarily consisted of a tailored program of physical therapy focused on progressive training in strength, balance, and gait for a period of 3 months. Participants in the intervention group also received screening and follow-up for vision, polypharmacy, and environmental hazards. Participants in the control group received usual care prescribed by a physician and educational materials on falls prevention.

Main Outcome Measures: The primary outcome measure was experiencing at least 1 fall during the 9-month study period (a 3-mo active intervention phase and a 6-mo maintenance phase). Secondary outcome measures were the occurrence of at least 1 injurious fall during the study period and a change in the Short Physical Performance Battery (SPPB) score. Participants were assessed both after 3 and 9 months.

Results: During the 9-month study period, 37.8% of the control group and 30.5% of the intervention group fell at least once, which was not statistically significantly different (odds ratio [OR]=.72; 95% confidence interval [CI], .46−1.12; P=.146). The intervention group had statistically significantly fewer individuals with injurious falls (OR=.56; 95% CI, .32−.98; P=.041) and less deterioration in physical performance, reflected by a mean difference of 0.6 in SPPB scores (P=.029). Multivariate analyses indicated a strong interaction effect between the intervention and the presence of 2 or more major comorbidities; after accounting for this effect, the intervention program reduced the number of people experiencing at least 1 fall (OR=.34; 95% CI, .17−.67; P=.002).

Conclusions: We observed that in this heterogeneous population, the proportion of participants experiencing at least 1 fall during the study period was not statistically significantly lower in the intervention group compared with the control group. Secondary analyses strongly suggest that individuals with 2 or more major comorbidities do not benefit from a tailored physical therapy program; however, individuals with less comorbidity may substantially benefit.

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Falls, particularly common in the elderly, are a leading cause of death, disability, and health care costs.[1,2] In Singapore, similar to other developed countries, falls represent the leading cause of trauma in the elderly and account for 85% of all elderly patients with trauma seen in the emergency department (ED).[3] With one of the most rapidly aging populations in the world, Singapore is experiencing falls in the elderly as an urgent public health challenge.

Research increasingly indicates that falls are both predictable and preventable for specific groups.[4-12] However, there is a scarcity of clinical trials of community-based programs intended for a broad range of individuals at high risk for falls. In light of this, we developed a multifactorial intervention program applicable to the heterogeneous group at risk of falls, adapted to the Singapore context. Based on existing studies or programs,[2,13-15] the program, Steps to Avoid Falls in the Elderly (SAFE), was designed as a practical model for a national falls prevention program including an individually tailored physical therapy program as well as screening and follow-up of other fall risk factors (vision, polypharmacy, environmental hazards). Key stakeholders responsible for various aspects of an eventual national program were engaged in the development and implementation of the intervention.

In this report, we describe the results of the SAFE study, a randomized controlled trial (RCT) to evaluate the effectiveness of SAFE to reduce the incidence of fallers during a 9-month study period among community-dwelling elderly who are seen in the ED with a fall.

Methods

Study design and setting

The SAFE study is a multicenter, 2-arm, parallel-group RCT. Participants were recruited from the ED of 2 tertiary care public hospitals; notably, in Singapore, public hospitals provide over 80% of ED services. The study protocol was approved by SingHealth Centralised Institutional Review Board.

Participants

Eligible participants were patients seen in the ED for a fall or fall-related injury and were Singaporeans or permanent residents, at least 65 years of age, able to perform the Three-Step Command Test,[16] and discharged home or admitted to the hospital but expected to recover weight bearing of the lower extremity within 1 month. Patients who attended the ED for road traffic collisions or needed emergency inpatient surgery were ineligible for the study.

Potentially eligible patients were approached by an ED nurse who acquired verbal consent to allow the study coordinator to schedule a home visit by a physical therapist who, in turn, obtained formal written informed consent from participants willing to enroll in the study.

List of abbreviations:

CI	**confidence interval**
ED	**emergency department**
OR	**odds ratio**
RCT	**randomized controlled trial**
SAFE	**Steps to Avoid Falls in the Elderly**
SPPB	**Short Physical Performance Battery**

Randomization and blinding

After consent and baseline evaluation, the physical therapist contacted the study coordinator by telephone for random assignment to intervention or control groups from a computer-generated list created by the study statistician, using the permuted-block randomization method, stratified by 2 recruitment sites and sex. All subsequent outcome assessments were performed by trained nurses not involved in the intervention and who were masked to the group assignment.

Procedures

The participants assigned to the intervention or the control groups were followed up for 9 months from the date of randomization. At the baseline assessment, physical therapists assessed the participants' orthostatic blood pressure, and lower extremity mobility using the Short Physical Performance Battery (SPPB)[17] as well as the 2-minute walk test.[18] The physical therapist administered a questionnaire that assessed cognitive function based on the Montreal Cognitive Assessment,[19] participants' history and nature of falls, the Modified Falls Efficacy Scale,[20] the list of medications, physical health status and related functional limitations,[21] a utility-based quality-of-life measure (EuroQol) and visual analog–assessed quality of life (EuroQol visual analog scale),[22] financial status, and health care utilization. Participants were given monthly falls calendars with instructions and a pedometer to wear for the following 7 days to track the number of steps taken daily.

The study period was divided into 2 phases: a 3-month "active intervention phase" and a 6-month "maintenance phase." At the end of each phase, the participants in both the control and the intervention groups were evaluated on the same measures as the baseline assessment by the blinded assessors and instructed to wear pedometers for the following 7 days.

During the study period, all participants were contacted monthly by the study coordinator via phone to record the number of falls they had in the past month and to verify any marked falls in the monthly falls calendars[13] that were returned. The participants were instructed to mark down the day on which they fell and mail the calendar at the end of each month to the study coordinator. If the participant fell during the previous month, the study coordinator recorded characteristics of the fall, including the cause, place, and whether the fall led to seeking medical attention or restricted daily activities. If the participant was deemed cognitively unfit, the proxy (a primary caregiver or anyone who lives with the participant, including a domestic worker) was contacted instead.

Interventions

As locally required for falls reduction exercise programs, each participant in the intervention group received a medical examination that was funded by the study at a designated clinic. The clinic physician examined the cardiovascular, respiratory, and musculoskeletal systems and issued a certification of fitness to participate in exercise for a period of 6 months from the date of physical examination. During this examination, the physician advised intervention participants with vision problems to seek care appropriately.

The baseline SPPB[17] was used to place the participants initially into a group or an individual home-based exercise program.[23,24] Participants with better physical performance (SPPB >6) were assigned to a group exercise program. This consisted of an evidence-based, 1-hour group exercise program, which was offered up to 24 sessions (2 times per week), and transportation was provided by the study.

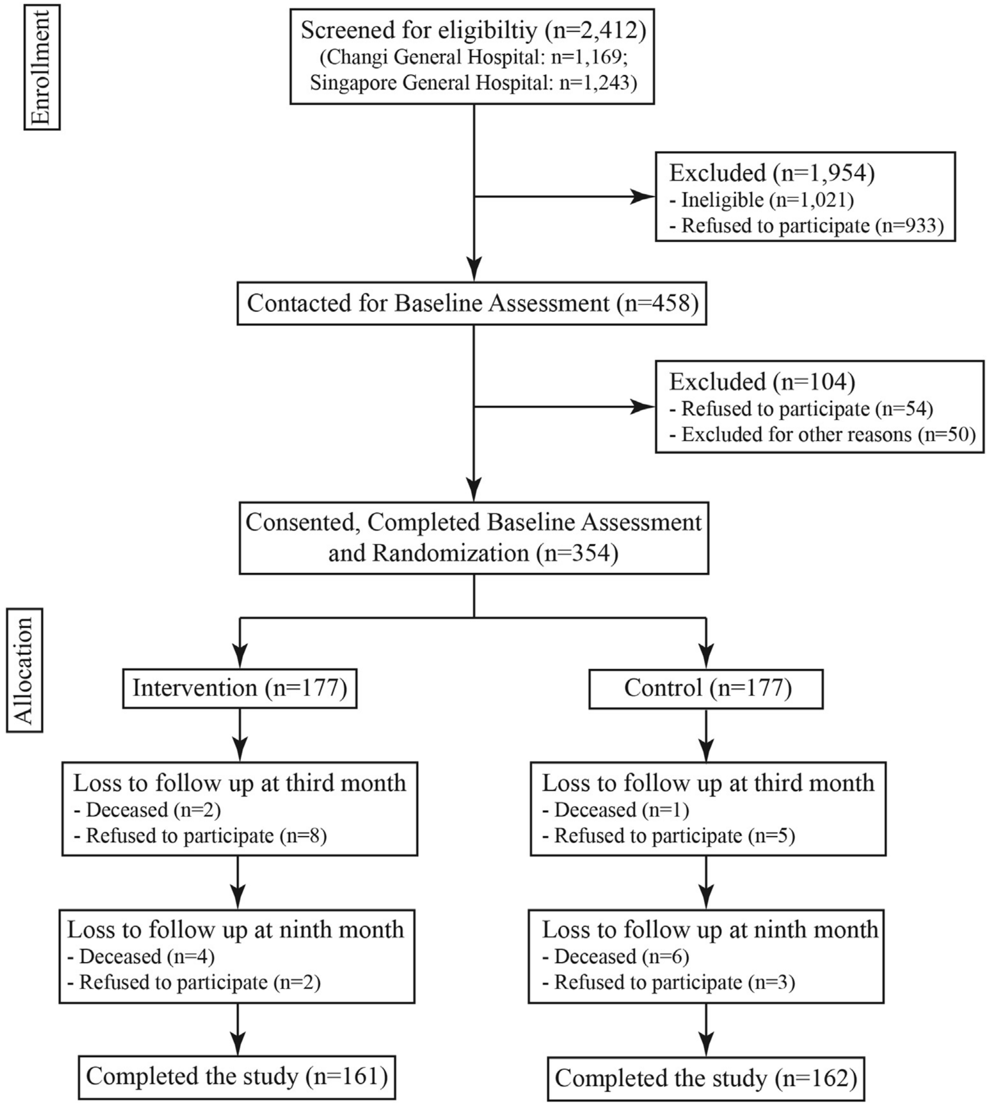

Fig 1 Consolidated Standards of Reporting Trials (CONSORT) flow diagram of the SAFE study.

Participants with poorer physical performance (SPPB <7) were given a home-based individual exercise program that specifically targets and modifies impairments that interfere with engaging in a group setting exercise program. This consisted of up to 12 sessions (3 times per week) conducted by a trained physical therapist.[13] These low-performance participants were assessed every fourth session for their physical and functional improvement. When they attained SPPB >6, they transitioned to a group exercise program and continued until the end of active intervention phase. The group exercise program was designed to serve as a continuation of the individualized exercise program.

As detailed in appendix 1, the broad range of exercises in this study was designed to be adaptable to a wide spectrum of physical functions, including those generally performed by frail older adults with comorbidities. Exercises were tailored to each participant's functional status. Particular emphasis was given to static and dynamic balance exercises of the lower extremities, and a key aspect of the study intervention was its structured, gradual progression toward the goals collaboratively set by participants and physical therapists. Participants in the intervention group were then transitioned to a maintenance phase in which they were encouraged to continue to exercise at home or participate in other group exercise programs.

In addition, physical therapists referred participants with polypharmacy to a nurse from the Agency for Integrated Care, an organization set up by Ministry of Health to facilitate coordination of outpatient services for medication review and reconciliation. Physical therapists also inspected the participants' homes for environmental hazards using the Centers for Disease Control and Prevention Home Checklist,[25] and provided appropriate advice. Participants were asked to self-rate their vision, and physical therapists encouraged participants to seek medical advice if the participant's self-rated vision was poor. The participants assigned to the control group received the usual care recommended by their physicians, which typically does not involve specialized falls prevention. In addition, both groups received educational materials on falls prevention. Appendix 2 describes the interventions in detail.

Outcomes

The primary outcome measure was whether a participant fell at least once during the 9-month study period. A fall was defined as "an event which results in a person coming to rest

Table 1 Baseline characteristics

	Randomized (n=323)		Lost to Follow-Up (n=31)	
Characteristics	Control (n=162)	Intervention (n=161)	Control (n=15)	Intervention (n=16)
Age (y)	77.4±7.2 (65–94)	78.2±6.9 (65–99)	79.6±7.1 (66–88)	79.3±4.2 (72–86)
Male	24.7	21.1	26.7	62.5
Race				
Chinese	80.3	85.1	80.0	75.0
Non-Chinese	19.8	14.9	20.0	25.0
Highest education level				
No formal education	37.7	34.2	46.7	25.0
Primary	29.6	32.9	26.7	31.3
Secondary	21.6	19.3	26.7	25.0
Above secondary	11.1	13.7	0.0	18.8
Marital status				
Married	58.0	50.3	46.7	68.8
Not married	42.0	49.7	53.3	31.3
Working status				
Working full-time or Part-time	5.6	5.0	0.0	0.0
Unemployed/retired/homemaker	94.4	95.0	100.0	100.0
Housing type				
HDB 1–3 rooms	28.4	31.1	33.3	26.7
HDB 4–5 rooms	58.0	49.7	40.0	33.3
Private housing	13.6	19.3	26.7	40.0
Availability of primary caregiver	85.1	87.0	86.7	87.5
Caregivers living with participant	72.8	68.9	66.7	68.8
Availability of foreign domestic worker	25.2	30.8	46.7	37.5
Difference in systolic blood pressure between supine and standing position (mmHg)	11.8±10.4 (0–60)	13.1±10.3 (0–50)	10.0±10.4 (0–50)	17.1±17.9 (3–75)
Polypharmacy	54.3	54.7	60.0	62.5
Vision				
Good	45.7	40.4	40.0	43.8
Poor	54.3	59.6	60.0	56.3
Multiple comorbidities*	46.3	47.8	53.3	62.5
Total SPPB score	6.6±3.3 (1–12)	6.2±3.6 (0–12)	3.7±2.3 (1–8)	5.9±3.5 (1–12)
Total MoCA score	18.7±7.1 (3–30)	18.5±6.9 (4–30)	17.0±6.9 (6–29)	18.6±7.7 (8–30)
Total MFES	93.1±38.6 (2–140)	87.9±40.3 (0–140)	75.6±36.2 (0–135)	79.1±42.9 (13–140)
Fell more than once in last 6mo before baseline assessment	37.0	46.0	40.0	50.0
Quality of life (EQ-5D-5L)	0.77±0.19 (0.083–1)	0.74±0.23 (0.023–1)	0.75±0.23 (0.178–1)	0.75±0.19 (0.314–1)
Quality of life (EQ-VAS)	71.2±18.0 (10–100)	68.3±20.2 (0–100)	69.9±24.3 (25–100)	62.9±16.4 (40–90)

NOTE. Values are mean ± SD (range) for continuous variables, and percentages for categorical variables.
Abbreviations: EQ-5D-5L, EuroQol-5D-5L; EQ-VAS, EuroQol visual analog scale; HDB, Housing and Development Board (responsible for public housing in Singapore); MFES, Modified Falls Efficacy Scale; MoCA, Montreal Cognitive Assessment.
* Two or more of emphysema, cardiac failure, circulation problem, stroke, Parkinson disease, cancer, and MoCA<26.

inadvertently on the ground or floor or other lower level."[26(p1)] Falls were determined from the monthly phone calls or falls calendars. One secondary outcome measure was whether the participant had at least 1 injurious fall during the study period. An injurious fall was defined as a fall for which the participant sought medical attention[27] or restricted his/her daily activities for at least 48 hours.[28] An additional secondary outcome was change in a participant's SPPB score as measured by blinded assessors.

Sample size

The initially proposed sample size of 300 (150 in each arm) was based on the assumption that the intervention would lead to a clinically meaningful reduction in the percentage of participants who experienced a fall during the study period, from 50% to 31%, corresponding to an odds ratio (OR) of .45. However, during the midpoint review by the study advisory committee, a lower falls rate in our study population was noted, and the sample size was increased to be at least

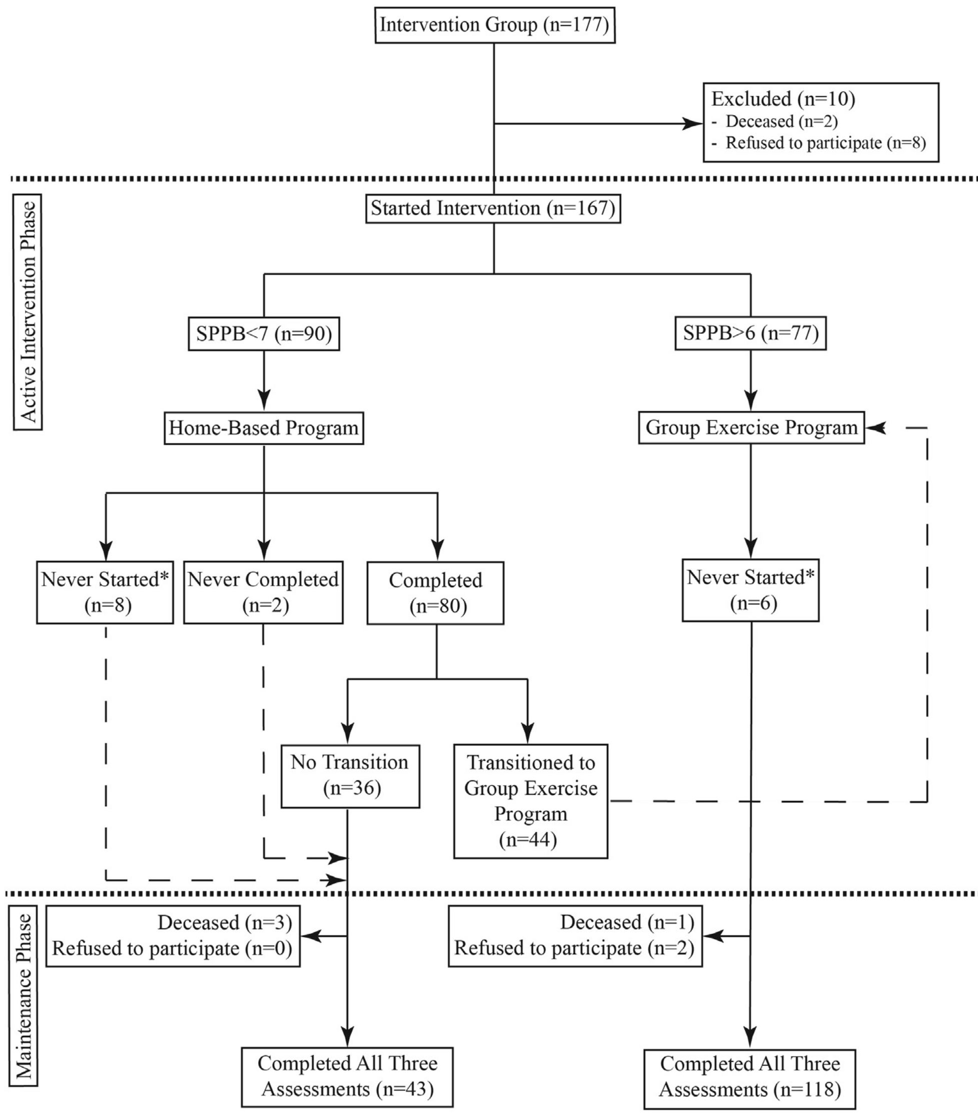

Fig 2 Progress of the exercise program. *Never started interventions but being followed up.

165 per arm, which would provide 90% power to discern a reduction in the proportion of participants who fell from 30% to 15%.

Statistical analysis

All the statistical analyses were done on an intention-to-treat basis and performed in Stata 13.1.[a] We compared baseline characteristics of participants in the 2 groups by using the chi-square test for categorical variables and Student *t* test for continuous variables.

We also compared cumulative outcome measures in the 2 groups by using the chi-square test for categorical variables and Student *t* test for continuous variables. Because of the heterogeneity of the population, including substantial variation in the presence of comorbidities, we examined the primary outcome for 2 subgroups: those with 2 or more major comorbidities (emphysema, cardiac failure, circulation problem, stroke, Parkinson disease, cancer, and Montreal Cognitive Assessment <26) and those with no more than 1 major comorbidity.[29] We also performed multivariable logistic regressions with an interaction effect between the intervention and the presence of 2 or more comorbidities or not. Model 1 adjusted for a direct and interaction effect of comorbidities; model 2, in addition, adjusted for participants' demographic characteristics and risk factors for falls. To avoid overfitting, we including only variables significant to the $\alpha=.05$ level. Potential for collinearity was assessed by the Pearson correlation coefficient of included variables and calculation of a variance inflation factor. No included variables had correlation coefficients exceeding .47, and the variance inflation

Table 2 Number (%) of participants in each group and relative risk (95% CI) of falling or incurring injurious falls over 9 months between groups

Group	Control (n=177)	Intervention (n=177)	Relative Risk Between Groups
Fallers	67 (37.8)	54 (30.5)	.72 (.46–1.12)
Injurious fallers	40 (22.6)	25 (14.1)	.56 (.32–.98)

NOTE. Values are n (%) or relative risk (95% CI).
Abbreviation: CI, confidence interval.

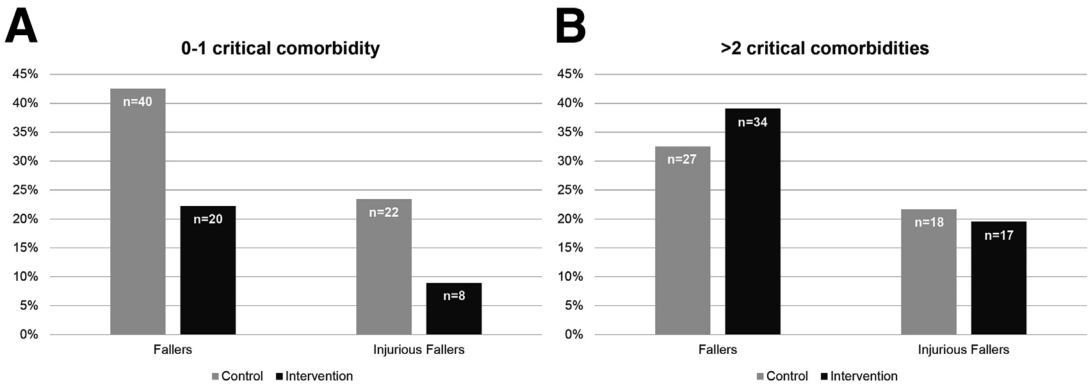

Fig 3 Proportions of fallers and of injurious fallers in 2 groups stratified by the number of critical comorbidities.

factor was <2. The SAFE study was registered with the U.S. Clinical Trials Registry, number NCT01713543.

Results

Figure 1 illustrates the flow of participants in the study. Of 2412 individuals screened, 1391 were eligible (58%); of these, 354 (26%) were consented, completed baseline assessment, and were randomized (177 each in the control and the intervention group). The dropout rate was low, approximately 5% in both groups. Participants who refused to enroll and those who consented to enroll were similar with regard to age and sex.

Recruitment took place between December 1, 2012, and July 17, 2014, and the last 9-month assessment was completed on May 23, 2015. Baseline demographic characteristics of participants are shown in table 1. There were no significant differences in the participants' demographic and socioeconomic information or risk factors for falls, and no evidence of bias introduced because of loss to follow-up (see table 1). Nearly half of all participants had 2 or more major comorbidities, and the overall average SPPB score was 6.4, indicating relatively low levels of physical performance.

Figure 2 summarizes the variety of therapy trajectories for the intervention subjects. Nearly all (79/81) participants assigned to the home-based exercise program completed the prescribed number of sessions. More than half (43/79) of participants with low physical performance improved to score above 6 for SPPB to attend the group exercise program after 5.2 home sessions, on average. Seventy-one participants assigned to the group exercise program attended 15 sessions, on average. About 75% (238/354) of the participants submitted at least 1 falls calendar throughout the study period. We observed that 82% of falls marked in the calendars were also recorded via phone calls.

Over the 9-month observation period, the overall proportion of participants who fell was 34% (121/354) (table 2). Fifty-four participants (31%) in the intervention group and 67 participants (38%) in the control group fell at least once during the study period (OR=.72; 95% confidence interval [CI], .46−1.12; P=.146). The risk of having at least 1 injurious fall was statistically significantly lower in the intervention group (OR=.56; 95% CI, .32−.98; P=.041). Performance scores on the SPPB decreased in both groups; however, the control group deteriorated significantly more than the intervention group, reflected by the difference of 0.6 on the SPPB score (P=.029); a difference in SPPB score of .27 to .55 is clinically meaningful.[30]

Figure 3 shows that when the participants were stratified by the presence of 2 or more major comorbidities, the participants without multiple major conditions were much less likely to have at least 1 fall if they were in the intervention group than if they were in the control group (OR=.39; 95% CI, .20−.73; P=.004). This benefit was not seen in the subgroup with multiple major comorbidities (OR=1.33; 95% CI, .71−2.50; P=.374). The same was seen for the proportion of individuals with at least 1 injurious

Table 3 Effect of exercise program on number of fallers during study period

	Model 1			Model 2		
Predictors of Fallers	OR	95% CI	P	OR	95% CI	P
Intervention	0.48	0.27−0.84	.011	0.34	0.17−0.67	.002
Multiple comorbidities*	0.91	0.48−1.73	.784	0.51	0.26−0.98	.044
Intervention × multiple comorbidities	3.15	1.25−7.95	.015	3.66	1.42−9.47	.007
Age				0.99	0.96−1.03	.784
Eyesight (poor vs good)				1.67	1.02−2.73	.040
Total SPPB score				1.00	0.90−1.11	.942
Total MoCA score				0.93	0.89−0.97	.001
Total MFES				1.00	0.99−1.01	.666
Fell more than once in last 6mo before baseline assessment				1.68	1.04−2.70	.034

NOTE. ORs and 95% CIs were generated from logistic regression models. Significant at P=.05. Model 1 adjusted for a direct and interaction effect of comorbidities. Model 2, in addition, adjusted for participants' demographic characteristics, and risk factors for falls.
Abbreviations: MFES, Modified Falls Efficacy Scale; MoCA, Montreal Cognitive Assessment.
* Two or more of emphysema, cardiac failure, circulation problem, stroke, Parkinson disease, cancer, and MoCA<26.

fall. In the logistic regression analysis, the intervention was effective when accounting for an interaction effect between the intervention and the presence of critical comorbidities (table 3). This was observed with and without adjustments for sociodemographic factors and other risk factors for falls.

Discussion

The SAFE study did not identify a statistically significant reduction in the number of participants who fell during the 9-month study period; however, a significant reduction in the likelihood of having at least 1 injurious fall and less deterioration in SPPB scores was observed in participants of the intervention group compared with participants of the control group.

In this heterogeneous high-risk population, we observed that the proportion of individuals who achieved the primary outcome of at least 1 fall in a 9-month study period was 8% lower in the intervention group compared with the control group, which was not statistically significant. This finding may not be surprising given the inconclusive results of previous published RCTs[4,8,11,31,32] of multifactorial fall prevention programs. However, the number of injurious falls was significantly lower in the intervention group (40 vs 25; OR = .56; 95% CI, .32−.98; P = .041). Of potential clinical significance, the results appear highly dependent on the presence of major comorbidities. When restricting the analysis to individuals with no major comorbidities, the rate of falls was substantially lower for those in the intervention group than the control group (22.2% vs 42.5%; OR = .39; 95% CI, .20−.73; P = .004); this significant difference persisted with statistical adjustment (OR = .31; 95% CI, .15−.65; P = .002). Recent studies report that increased fall rates are attributable to the presence of specific comorbidities[33]; indeed, a fall may represent a signal event that the person has lost resilience in multiple organ systems and falls prevention programs have little to offer in reducing the ensuing rapid deterioration.[34-36] We observed that 4.7% of the high-comorbidity subjects had died by the end of the study in comparison to 2.1% of the low-comorbidity subjects.

The low rate of falls in this high-risk population compared with Western populations is a potentially important observation and deserves explanation. A possible explanation includes high levels of protectiveness by family and caregivers after an elder has fallen.[37,38] Moreover, more than 70% of participants had an available primary caregiver living with the participant, and almost 30% had a live-in domestic worker. If the relatively low rate of falls is related to overprotectiveness, this may unintentionally diminish the effectiveness of falls prevention programs for the highly disabled at risk of falling, and should be addressed.

This study has several substantial strengths, including a strong study design, with subject-level randomization, and the randomization produced a balanced intervention and control population. It was highly pragmatic, including a broad range of high-risk individuals with a wide range of baseline SPPB scores and cognitive function, and limited exclusion criteria—primarily to individuals with such severely injurious falls that they could not be expected to be weight bearing 1 month after the index fall.

One future direction of research on falls prevention suggested by this work is to develop a better understanding of the regional differences in falls risk, the cultural context, and potential strategies for allowing the elderly who are at risk of falling to regain balance, strength, confidence, and mobility. We also found that cognitive impairment remained a strong predictor of falls, and the impact of cognitive interventions in falls prevention merits further study. This study reinforces the view that a falls prevention program is a complex service that needs to be individually tailored based on the patient's comorbidities and cognitive function, and cannot be treated as a black box to be applied uniformly with the expectation of similar results.

Study limitations

The primary weakness of the study is that the power was limited by a lower-than-expected rate of falls in the study population. The rate of falls in the study population was about two thirds of the predicted rate based on previous studies of recurrent falls—34.2% in the current study versus 50.5% reported elsewhere.[39] Our efforts to adjust the sample size were limited by funding and time constraints. However, straightforward and consistent statistical analyses were useful in addressing this issue. Another weakness of this study is the lack of baseline or follow-up data of the control subjects regarding home environment, vision, or polypharmacy; this reduced our ability to control for changes in these factors.

Conclusions

This study did not significantly reduce the overall proportion of participants who fell at least once over the entire study period but did result in a significant reduction in the number of injurious fallers. We also observed the moderating effect of the presence of comorbidities on the risks of falls. The implications of this study relate to further development of falls prevention programs at a national level in Singapore and elsewhere where demographic shifts raise falls to the level of a public health concern. For elderly patients seen in the ED for falls with few major comorbidities, a tailored falls prevention program like the SAFE may reduce recurrent falls. Future, larger studies should be aimed at confirming the value of similar falls prevention interventions in individuals without multiple major comorbidities as well as identifying more effective falls prevention strategies for the elderly at risk of falling who are more severely ill.

Supplier

a. Stata 13.1. StataCorp LP.

Keywords

Accidental falls; Frail elderly; Randomized controlled trial; Rehabilitation

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Appendix 1 Progressive Exercise Grid

	Level 1	Level 2	Level 3	Level 4
A. Endurance	***Continuous**, habitual walking speed. Walking aids allowed.*			
	"Able to walk for <2min"	*"≥2min, but <10min"*	*"≥10min, but <20min"*	*"≥20min"*
B. Mobility				
Walking speed over 4m	*"≤0.4m/s"*	*">0.4m/s but ≤0.6m/s"*	*">0.6m/s but ≤1.0m/s"*	*">1.0m/s"*
C. Balance	*"**Unable** to stand feet together for **10s**"*	*"**Able** to stand with feet together **≥10s**"*	*"Able to **stand unsupported & reach forward 10in**"*	*"Able to **stand on 1 leg** for **10s**"*
1. Standing Balance	Shoulder-width stance for *30s*.	a. Feet together *30s*, progress EO → EC	a. Tandem *30s*, progress EO → EC	a. SLS with no support, try 10s to 30s. Repeat with other leg.
	Progress EO → EC.	b. Feet in semitandem or staggered stance, progress EO → EC	b. SLS with support, try 10s progress to 30s. Repeat with other leg.	
2. Stand and Reach Balance	a. Stand reach forward, reach backward as far as possible, manage only <6in	Stand reach forward; reach backward as far as possible 10in.	Stand with feet together, reach forward as far as possible 6in progressing to 10in.	Stand with staggered or semitandem stance, reach forward as far as possible 6in progressing to 10in.
	b. Stand reach forward, reach backward as far as possible, managing ≥6in, <10in			
D. Integrative Mobility Training	a. Increasing walking speed; b. Dynamic start and stop	c. Dynamic turning—90°, 180°, figure of 8	d. Challenge with verbal distraction	e. Walking while carrying object
E. LL Strength	*Level 1 & 2 can sit on edge of chair & lean forward*		*Level 3 & 4 sit in back of chair*	
As much as possible, do strengthening in standing	*"**Unable** to rise from chair **without use of hands**"*	*"**Able** to rise from chair **without using hands** at least once"*	*"Able to do as per level 2—**5 times in >15s but <60s**"*	*"Able to do as per level 2—**5 times in ≤15s**"*
Functional				
a. STS from bed	Low levels 1—To roll, sit up in bed. Assisted STS. Needs to be able to complete 5 before progressing.			
b. STS from chair	a. Move to edge of chair, lean forward, ***push*** with arms, and stand up.	a. Move to edge of chair, lean forward, ***put arms out front***, and stand up.	a. Sit back in chair, ***put arms out***, stand up.	a. Perform 5 repetitions as above as quickly as possible while remaining safe.
		b. Move to edge of chair, lean forward, ***fold arms*** across chest, and stand up.	b. Sit back in chair, ***fold arms*** across chest, and stand up.	b. Lower seat height by placing 6-in platform in front of chair.
		c. Sit back in chair, ***push*** with arms, and stand up.		
c. Step ups	Use 4-in step	Use 6-in step	Use 8-in step	Add resistance or ↑ to 10in
d. Side step ups	Progress: hold with both hands support → 1 hand support → no support. Progress to next step height once able 1 set of 10 reps without holding.			

(*continued on next page*)

Appendix 1 (*Continued*)

e. Calf raise	a. Sitting, active plantar flexion. b. Standing with bilateral UL support, ***bilateral heel raise***.	a. Standing with 1-hand support, ***bilateral heel raise***. b. Standing with no support, ***bilateral heel raise***.	a. Standing with bilateral UL support, ***single-leg heel raise***. Repeat on other leg. b. Standing with 1-hand support, ***single-leg heel raise***. Repeat on other leg.	Standing without support, ***single-leg heel raise***. Repeat on other leg.
Resistance				
a. PNF	Level 1—unilateral D1, D2 flexion/extension patterns for UL and/or LL. Progress to gentle active assisted resistance work until participant can complete 1 set of 10.			
b. LL 1. Hip abduction 2. Hip flexion 3. Hip extension 4. Knee flexion 5. Knee extension c. UL 1. Shoulder press 2. Shoulder abduction 3. Elbow flexion 4. Elbow extension	1. Gravity eliminated, active assisted 2. Gravity eliminated, active 3. Against gravity, no resistance 4. PNF *Hip extension—can start with bilateral bridge, progress to unilateral bridge. ***Once patient can complete 1—2 sets of 10 reps without exceeding RPE 4—5/10, ↑ resistance.**	Standing against gravity (with UL supported) with Theraband 5. Yellow 6. Red 7. Green 8. Blue 9. Black 10. Silver With weights 11. Free weights—record weight.		

Abbreviations: EC, eyes closed; EO, eyes opened; LL, lower limbs; PNF, proprioceptive neuromuscular facilitation; RPE, rating of perceived exertion; SLS, single leg stand; STS, sit to stand; UL, upper limbs.

Appendix 2 Description of Intervention

Intervention Item	Measurement	Definition	Who Conducted Measurement	When	What
Deficiencies in gait, balance, or mobility	SPPB	SPPB >6	PT	Baseline assessment	Group exercise program
		SPPB ≤6			Home exercise program
Polypharmacy	PT reviewed medications that participants were taking on the day of baseline assessment.	>4 prescribed medications	PT	Baseline assessment	PT referred participants to AIC transition care coordinators.
Environment hazards	CDC Home Checklist	Floors, kitchen, stairs, bedroom, and bathroom were assessed for any environmental hazards.	PT	Baseline assessment	PT advised participants on hazardous areas (ie, grab bars in bathroom).
Poor vision	Self-report	Participants were asked to rate their vision as one of the following: poor, fair, good, or excellent.	PT	Baseline assessment	PT encouraged participants to seek medical advice.
	Snellen chart and pinhole ocular occlude if necessary	Standard visual acuity score was used.	Physician	Medical screening before exercise program	A physician advised participants on treatments for vision accordingly.

Abbreviations: AIC, Agency for Integrated Care; CDC, Centers for Disease Control and Prevention; PT, physical therapist.

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