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ORIGINAL ARTICLE

Effect of a fall prevention program for elderly persons attending a rural family medicine center, Egypt

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Abstract

Background In Egypt, few studies have explored the problem of falling and interventions to prevent falls in older adults.
Objective To assess the effect of multifactorial, individualized interventions for prevention of falls among elderly persons.
Methods A quasi-experimental intervention study design with pre-post assessment was used. A sample of 100 community-dwelling persons aged 60 years or older was selected from the Fanara Family Medicine Center regestries. An evidence-based, coordinated fall prevention program was implemented. The primary outcome measure was rate of falls assessed at baseline and 12 months. The secondary outcomes were changes in home hazards, functional status, muscle strength, balance and adherence to Otago exercises.
Results There was a statistically significant difference in rate of falls ($P = 0.049$) and recurrent falls ($P = 0.011$) among participants from baseline to 12 months post-intervention. There were statistically significant improvements from baseline to post-intervention in dynamic balance ($P = 0.02$), muscle strength ($P < 0.001$), adherence to Otago exercises ($P < 0.001$) and the total score of home hazards ($P = 0.029$).
Conclusion The multifactorial fall prevention program was effective in reducing the rate of falls and most home hazards and improving functional performance and balance abilities in community-dwelling older adults after 1-year follow-up.

Keywords Elderly · Fall prevention · GARS · Otago exercises

Introduction

Falls are one of the most common and serious threats to older individuals because they can be associated with considerable morbidity, decreased functioning, premature nursing home admissions or even death (Stevens et al. 2012). The health burden of falls also includes injury-related high health care consumption, costs and reduced quality of life. The rate of hospital admission due to falls for people aged 60 years and over in Western countries ranges from 1.6 to 3.0 per 10,000 population. Falls account for 40% of all injury-related deaths (Hartholt et al. 2011; WHO 2007).

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Annually, about 28–35% of persons 65 years or older fall at least once with an increase to 32–42% after the age of 70, and 15% of elderly people fall at least twice. The frequency of falls among aging populations living in nursing homes is higher than among community-dwelling older people. (WHO 2007: Sandholzer et al. 2004). Falls among the elderly can be due to intrinsic factors [e.g., age, female gender, solitary lifestyle, medications, medical conditions (arthritis, chronic obstructive pulmonary disease, depression and vascular diseases) and gait problems] or extrinsic factors (e.g., environmental causes such as poor lighting, slippery floors and uneven surfaces) (Dionyssiotis 2012).

Evidence-based fall prevention programs may benefit older people with risk factors for falls and fall-related injuries (Grundstrom et al. 2012). Family physicians have an important role in screening older patients for risk of falls, implementing single- or multicomponent fall preventive interventions in co-operation with other health professionals and supporting the patient uptake of recommendations. An enhanced primary health care plan can facilitate the implementation of fall prevention programs (Al-Aama 2011; Australian Commission on Safety and Quality in Health Care ACSQHC 2009).

The authors found few published studies about the problem of falls and coordinated primary care interventions designed to prevent them in older adults. Therefore, this study aimed to assess the effect of multifactorial, individualized interventions on rate of falls among the elderly living in the community and attending a rural family medicine center.

Null hypothesis H0: Multifactorial, individualized interventions for the prevention of falls could not make a significant difference between pre- and post-intervention in the rate of falls among elderly people living in the community and attending a rural family medicine center.

Alternative hypothesis H1: Multifactorial, individualized interventions for the prevention of falls could make a significant difference between pre- and post-intervention in the rate of falls among elderly people living in the community and attending a rural family medicine center.

Methods

Study design A quasi-experimental intervention study design with pre-post assessment was used for evaluation of the effect of a fall prevention program. **Setting:** Recruitment and medical examinations took place in the Fanara Family Medicine Center, which is affiliated with the Suez Canal University Hospital in Ismailia Governorate, to which referrals for specific interventions were also made. Home hazards and Otago exercise program components were home-based. The study was conducted between January 2015–May 2016.

Study population The study was conducted on elderly persons aged 60 years or older who were attending the Fanara Family Medicine Center. **Inclusion criteria:** Community-dwelling persons. **Exclusion criteria:** Elderly people needing human assistance for performing the basic activities of daily living and those living in a nursing/residential home with a terminal disease or cognitive impairment as identified by Callahan Six-item Screener (Callahan et al. 2002). The study sample was obtained through simple random sampling from registries. Based on a reduction in rate of falls from 52 to 32% in a previous study (Close et al. 1999), the sample size was calculated to be 72 elderly subjects + 20% dropout (14 elderly subjects) = 86 elderly subjects and was expanded to include 100.

Study tools

Patients were interviewed by the first author using valid and reliable tools:

CAREFALL Triage Instrument (CTI): personal data including, name, date of birth and gender of the participants and 44 items to assess history of falls and modifiable risk factors for recurrent falls in elderly patients such as: frequency of falling, circumstances of current fall, fall history, mobility before falls and high risk of osteoporosis, vision, urinary incontinence, social situations, depression and chronic diseases with one open-ended question about medications (Boele van Hensbroek et al. 2009).

Groningen Activity Restriction Scale (GARS): used to measure disability in activities of daily living (ADL) and instrumental activities of daily living (IADL). The response is based on what the patient is able to do rather than what s/he usually does. It included 18 items with a minimum score of 18 and maximum of 72. The higher the score is, the greater the disability (Kempen et al. 1996). The instrument was translated into Arabic and had been validated in a previous study (Kamel et al. 2013).

Home Falls and Accidents Screening Tool (HOME FAST): assessed the conditions that may contribute to falls at home: bathroom, floors, furniture, lighting, mobility, stairways/steps and storage. It included 25 questions, and hazards were scored as being present or not. The higher the score is, the higher the risk of falling (Mackenzie et al. 2000).

Physical examination: equipment used included weight and tape scales to measure the body mass index, a mercury sphygmomanometer to measure blood pressure in the sitting, prone and standing positions and a Snellen chart to assess visual acuity. A stopwatch and two armchairs for functional assessment of the exercise program were also used in two tests: **Timed up and go test (TUGT)**: a tool to measure older adult mobility and dynamic balance abilities that measures the time taken to stand from a chair, walk 3 m and return to the chair. A score of ≥ 14 s has been shown to indicate a high risk of falls (Herman et al. 2011; Shumway Cook et al. 2000).

The 30-s chair stand test (30s-CST): a measure of leg strength and endurance, it consists of manually counting the number of sit-stand-sit cycles completed during the 30 s of the test (Jones et al. 1999; Rikli and Jones 1999).

Multifactorial intervention program

The intervention program components were based on the Falls Assessment Clinical Trial (FACT) (Elley et al. 2007) with the modification of referral to specialists instead of to family physicians. Each participant received different combinations of interventions based on his/her individual assessment.

Fall-related medical problem assessment and management

Each participant received an individualized assessment, education, prescription and modification of treatment at

the Fanara Family Medicine Center. Referral of patients to specialists in the Suez Canal University Hospital was initiated when deemed necessary and included referral to an ophthalmologist when visual acuity was < 20/40 on the Snellen chart and referral to a physiotherapist for patients with gait disorders.

Bone health assessment and management

An assessment of high risk for osteoporosis was carried out. Supplementation with calcium and vitamin D was prescribed in appropriate doses. Referral for a bone density scan was made in case of previous fragility fractures. Proper management included bisphosphonates (Liberman and Cheung 2015).

Home hazard assessment and modifications

Each participant received baseline and post-intervention assessments; the first home visit was made within 2 weeks of the initial examination to evaluate home hazards and environmental safety. The participants received appropriate advice on changes needed and education about activities to reduce risk of falls (Cumming et al. 1999).

Otago exercise program

An evidence-based fall prevention program was delivered at home, with a minimum seven home visits. Elements included strength, balance and walking exercises and a focus on major lower limb muscles—knee flexors, knee extensors and hip abductors—for functional movements and walking. Ankle dorsiflexor and plantar flexor muscles were trained for recovering balance (Tools to Implement the Otago Exercise Program 2016). Participants were encouraged to complete the exercises three times a week. This took about 30–45 min per week. Participants were encouraged to walk outside the home at least twice a week to help increase physical capacity. Participants who exercised at least 3 days/week were classified as having good compliance, while poor compliance was defined as performing exercises < 3 days/week (Kuptniratsaikul et al. 2011).

The intervention program was delivered by the first author, with the assistance of a nurse trained in home visits and specialists working at the Suez Canal University Hospital if referral was needed. The program started with one 30–45-min session for assessment and management at the Fanara Family Medicine Center. Each person received a home hazard assessment, modification advice and 30–45 min of training sessions for performing Otago exercises at home, with a minimum of eight sessions.

Each participant received a diary for 12 months to register any falls during the year of follow-up, a booklet containing illustrations and instructions about home safety, Otago visit charts for prescribing the level of exercise and a calendar for recording adherence to Otago exercises. TUGT and 30s-CST were used to monitor a participant's success with Otago. Participants were contacted monthly by telephone for an interview about their falls and any consequences relating to the previous month and encouraged to adhere the Otago exercise program.

Primary outcome variables: rate of falls during 1 year follow-up: The percentage of elderly people reporting one or more falls over the 12-month follow-up and the percentage of recurrent falls (two or more) during the 12-month follow-up. A fall was defined as "an unexpected event in which the participants come to rest on the ground, floor, or other lower level (Lamb et al. 2005). Injuries as consequences of falls were classified as moderate (abrasions, bruising, cuts, decrease in physical function for a period of 3 days or more, sprains or sought medical attention) or serious (fractures, hospital admission or sutures required). The variables were reported by the participants at baseline and 12 months.

Secondary outcome variables Patient daily functioning (ADL, IADL, GARS), functional assessment by Otago exercises (TUGT, 30s-CST) and compliance with Otago exercises were assessed at baseline, 6 and 12 months. Home hazards were assessed at baseline and 12 months.

Statistical analysis Data were analyzed by the Statistical Package for Social Sciences (SPSS), version 20. Continuous data were tested for normality using the Shapiro-Wilk test. Non-parametric tests were used for comparison between categorical variables and continuous non-normally distributed variables. McNamara's test was used to analyze dichotomous dependent variables in paired comparisons. Friedman's test was used to detect differences in functional status, strength and balance abilities as continuous, not normally distributed data across three time points, with post hoc analysis using the Wilcoxon signed-rank test. Cochran's Q was used to compare categorical data across three time points, with post hoc analysis using McNemar's test. The P value was considered statistically significant if ≤ 0.05 and < 0.017 for multiple comparison.

Results

One hundred participants were included at baseline and 6 months after the study, with a 100% response rate, but unfortunately 3% were missing after 12 months because of participants passing away. The age of the elderly persons ranged from 60 to 79 years with a mean of 65.1. Nearly two thirds

(63%) of participants had a positive history of falls, and 39% of fallers experienced recurrent falls. Injuries following falls occurred in half of fallers, the most frequent injury being bruising (31.7%). Fractures, classified as serious injuries from falls, occurred among 4.7% of the cases (Table 1). The entire study sample (100%) received education on Otago exercises, more than half (62%) followed instructions about home hazard correction, and referral to ophthalmologists was needed in (14%) of participants (Table 2).

There were statistically significant differences in the proportions of falls and recurrent falls: Baseline to post-intervention falls decreased from 63.4 to 49.5%, respectively, and recurrent falls reduced from 40.8% at baseline to 25.8% post-intervention (Table 3).

There was a highly statistically significant improvement in ADL, IADL, GARS and 30s-CST scores, ($P < 0.001$) between the time points (baseline, post 6 months and post 12 months) (Table 4). There were statistically significant improvements in 30s-CST scores ($P < 0.001$), TUGT scores ($P = 0.02$) and compliance with Otago exercises between the time points (baseline, post 6 months and post 12 months) (Table 5).

The scores of some home hazards elements, e.g., the condition of floors, lighting, storage and mobility ($P < 0.05$). There were significant improvements in the total score of home hazards ($P < 0.05$) (Table 6).

Table 1 Baseline demographic and clinical characteristics of the study sample

Characteristic	Total ($n = 100$)
Age in years, mean (SD)	65.1 (4.7)
Females, *n* (%)	66 (66%)
Smokers, *n* (%)	24 (24%)
No. of medical conditions, median [IQR]	2 [1–3]
No. of medications, median [IQR]	1 [0–4]
Previous cerebrovascular incidents, *n* (%)	1 (1%)
Systolic blood pressure (mmHg), mean (SD)	130.2 (14.9)
Diastolic blood pressure (mmHg), mean (SD)	82.7 (8.3)
Height, mean (SD)	161 (6.2)
Weight, mean (SD)	74.8 (10.9)
Body mass index (kg/m^2), mean (SD)	26.9 (3.9)
Falls in previous year, *n* (%)	63 (63%)
Once	24 (24%)
Recurrent (2 or more)	39 (39%)
Consequences of falls ($n = 63$)	
None	30 (47.6%)
Bruising	20 (31.7%)
Cuts	3 (4.8%)
Fractures	3 (4.8%)
More than one injury	7 (11.1%)

IQR interquartile range

Table 2 Frequency participants received one or more individualized interventions ($n = 100$)

Intervention	Frequency (%)
Medication changes	
Medication added	11 (11)
Medication reduced	8 (8)
Medication withdrawn	6 (6)
Balance and gait	
Walking aids	16 (16)
Diagnosis and treatment of underlying cause	8 (8)
Advice on footwear	43 (43)
Physiotherapy referral	5 (5)
Bone health	
Calcium and vitamin D	6 (6)
Referral for DEXA scan	2 (2)
Biphosphonate treatment	1 (1)
Impaired vision	
Advice on glare-free lighting	36 (36)
Referral to ophthalmologist	14 (14)
Urinary incontinence	
Advice on night lights	18 (18)
Bladder training	18 (18)
Postural hypotension	
Compensatory strategies	5 (5)
Pressure stockings recommended	5 (5)
Referral to cardiologist	2 (2)
Home safety	
Identify and modify minor home hazards	62 (62)
Exercise	
Otago exercise program	100 (100)

Discussion

According to the current study, our intervention was associated with a significant reduction in rate of both single and recurrent falls among participants leading to acceptance of the alternative hypothesis. Similar findings were reported in Egypt by El-Gilany et al. (2013) who found that multiple interventions individually delivered to elderly persons in a rural community were associated with a significant reduction in the rate of recurrent falls after 1-year follow-up. These findings agreed with the PROFET study in the UK, which indicated that an interdisciplinary approach to this high-risk population can significantly decrease the risk of further falls and limit functional impairment (Close et al. 1999). Similar conclusions were reached by studies in Canada, the UK and New Zealand (Cusimano et al. 2008; Davison et al. 2005; Robertson et al. 2002). Several randomized trials, systematic reviews and meta-analyses have shown and supported the theory that multi-intervention

Table 3 Comparison of baseline and 12 months post-intervention for falls, recurrent falls and injuries

Variable	Baseline ($n = 93$) No. (%)	Post ($n = 93$) No. (%)	McNemar's test P value
Patients reporting falls (≥ 1)	59 (63.4)	46 (49.5)	0.049*
Recurrent falls (≥ 2)	38 (40.8)	24 (25.8)	0.011*
Injuries after falls[a]	32 (34.4)	16 (17.2)	0.327

*$P \leq 0.05$ is significant

[a] Contusion/hematomas, wounds and fractures

strategies can prevent falls in community-dwelling, cognitively intact elderly adults by 20%–45% at both high and low risk for falls (Gillespie et al. 2003).

On the other hand, a study by Shumway-Cook et al. (2007) reported that a community-based, multifactorial program only produced small but significant improvements in fall risk factors (strength, balance), but did not reduce the incidence rate of falls in sedentary, healthy, community-living older adults in a 12-month period. Previous studies in The Netherlands by Hendriks et al. (2008) and in Canada by Hogan et al. (2001) found that the multidisciplinary fall prevention program was not effective in preventing first falls and functional decline among the elderly with a history of falls.

Differences between the outcomes of previous studies can be explained by variations in intervention designs or in the studied populations. It is possible that patients enrolling in trials that showed favorable outcomes of the multifactorial fall intervention program were more at risk of falling and therefore more likely to benefit from the program than patients assessed in those trials that showed ineffectiveness of the program. Also, issues in participant adherence to recommendations may have varied between the studied populations, and different methods may have been used to assess them.

According to our study findings, there was an improvement in functional status of elderly individuals as assessed by GARS scores across three time points, namely, at baseline and 6 and 12 months post-intervention. Specific measurement of ADL and IADL showed significant improvements post-intervention. This finding is consistent with previous results by El-Gilany et al. (2013) who found that the percentage of dependent elderly decreased significantly after interventions as measured by ADLs and IADLs. Similar findings were reported by Gitlin et al. (2006), who found that community-dwelling older adults with functional difficulties benefited from a multicomponent intervention that addressed both environmental and behavioral factors, with participants demonstrating greater confidence in managing ADL after 6 months of intervention. The PROFET study by Close et al. (1999) found that a multidisciplinary fall prevention program had favorable effects on daily functioning and could significantly limit functional impairment among high-risk populations.

In contrast, Hendriks et al. (2008) demonstrated a lack of effectiveness of a multidisciplinary fall prevention program in elderly people at risk; in their study, the program was found to affect neither falls nor daily functioning. Another study by de Vries et al. (2010) that was conducted to evaluate the effectiveness of a multifactorial intervention in older persons with a high risk of recurrent falls also showed no effect on functional status as measured by ADL.

Our study showed that individualized fall risk treatment with simple exercises can significantly increase balancing abilities and lower limb muscle strength and improve the functional assessment as indicated by TUGT and 30s-CST scores. These improved outcomes may be due to the encouragement of the elderly to be aware of falls and to perform regular exercise at home. Our findings are consistent with findings from an Asian study by Lee et al. (2013) that found the

Table 4 Comparison of participants' daily functioning at baseline, 6 months and 12 months after intervention

Variables	Baseline Median [IQR]	Post 6 months Median [IQR]	Post 12 months Median [IQR]	Friedman's test	P value	Baseline vs. post 6 months[a]		Baseline vs. post 12 months[a]		Post 6 months vs. post 12 months[a]	
						Z	P value	Z	P value	Z	P value
ADL	14 [12–17]	13 [12–16]	12 [11–15]	20.1	< 0.001[b]	−3.97	< 0.001[b]	−3.34	< 0.001[b]	−0.105	0.916
IADL	21 [15–24]	18 [14–22]	18 [14–22]	39.4	< 0.001[b]	−5.16	< 0.001[b]	−3.99	<0.001[b]	−0.372	0.710
GARS	34 [28–40]	32 [25–40]	30 [25–39]	53.7	< 0.001[b]	−6.01	< 0.001[b]	−5.65	< 0.001[b]	−0.90	0.368

IQR interquartile range, *ADL* activities of daily living, *IADL* instrumental activities of daily living, *GARS* Groningen activity restriction scale

[*] P value is significant if ≤ 0.05 or < 0.017 for multiple comparisons

[a] Posthoc analysis with Wilcoxon signed-rank test (Z)

Table 5 Comparison of participants' muscle strength and balance, compliance with Otago exercises at baseline, 6 months and 12 months after intervention

Variables	Baseline Median [IQR]	Post 6 months Median [IQR]	Post 12 months Median [IQR]	Friedman's test	*P* value	Baseline vs. post 6 months[a]		Baseline vs. post 12 months[a]		Post 6 months vs. post 12 months[a]	
						Z	*P* value	*Z*	*P* value	*Z*	*P* value
TUGT	16 [11–22]	14 [11–20]	14 [11–20]	66	0.02*	−2.14	0.03*	−1.88	0.06	−1.94	0.85
30s-CST	14 [11–17]	15 [12–18]	15 [11–17]	67.5	< 0.001*	−3.55	< 0.001*	−6.48	< 0.001*	−4.54	< 0.001*
Variable	Baseline n (%)	Post 6 months n (%)	Post 12 months n (%)	Cochran's Q	*P* value	McNemar	*P* value	McNemar	*P* value	McNemar	*P* value
Compliance with Otago exercises	0 (0%)	38 (40.9%)	83 (89.2%)	125	< 0.001*	36.3	< 0.001*	74.1	< 0.001*	43.1	< 0.001*

Post hoc analysis of Cochran's Q with McNemar's test

IQR interquartile range, *TUGT* timed up and go test, 30s-CST = 30-s chair stand test

**P* value is significant if ≤ 0.05 or < 0.017 for multiple comparisons

[a] Post hoc analysis of Friedman with Wilcoxon signed-rank test (Z)

multifactorial fall prevention program with exercise intervention was beneficial in improving functional performance as demonstrated by a great improvement in the TUGT scores. However, it also appeared that the immediate improvement in function and physical performance did not lead to a reduction in fall incidence over a longer time. Similarly, Shumway-Cook et al. (2007) found that community-based, multifaceted intervention was effective in improving balance, mobility and leg strength, as demonstrated by small but significant improvements in both the TUGT and 30s-CST.

A study by Vogler et al. (2012) also found that balance improvements and fall risk reductions were reported in a 12-week home-based exercise program for older people; however the beneficial effects were found to be partially or even totally lost 12 weeks after cessation of the intervention. These findings were in contrast to de Vries et al. (2010) who found that a multifactorial fall prevention program has no effect whatsoever on physical performance measured by TUGT scores.

The present study showed that there was a significant improvement in compliance with Otago exercises from baseline to post-intervention, as supported by the improvements in the TUGT and 30s-CST measures. However, they are in contrast to findings by Kuptniratsaikul et al. (2011) who reported that although compliance was good (most subjects performed exercises regularly, at least 3 days/week), it had no effect on functional assessments including TUGT and 30s-CST scores. They explained this finding by the low sample size and the fact that most of the participants were young-old with a mean age of 67.1 years, so their balance ability many be better than participants in other studies.

In our study, we found a significant decrease in the scores for the home hazards category and some of its items such as condition of floors, lighting, storage and mobility ($P < 0.05$). These findings may be due to increasing awareness about environmental hazard modification and safety measures. Similar findings were reported by El-Gilany et al. (2013) who found a significant decrease in the scores of total home hazards and of all its items post-intervention.

Our findings were consistent with the study by Gillespie et al. (2003) who stated that home modifications included removal of tripping hazards, installing grab bars next to the toilet and in the bathtub or shower, using non-slip mats in the bathtub and on shower floors, putting handrails on both sides of stairways and improving home lighting may be effective in reducing falls.

Limitations of the study

No control group was selected for comparison. A randomized controlled study is required to confirm the effect of the program.

Table 6 Baseline and post-intervention changes in home hazards ($n = 93$)

Home hazard	Baseline Median (IQR)	Post 12 months Median (IQR)	Wilcoxon signed-rank test (Z)	*P* value
Floors	6 (5–7)	5 (4–6)	−2.62	0.009*
Furniture	2 (2–3)	2 (2–3)	−1.86	0.06
Lighting	4 (3–5)	3 (3–4)	−2.15	0.03*
Bathroom	8 (7–9)	8 (7–9)	−1.07	0.28
Storage	2 (2–3)	2 (2–3)	−2.13	0.03*
Stairways/steps	7 (5–8)	7 (5–8)	−1.79	0.07
Mobility	4 (3–5)	3 (3–5)	−2.61	0.009*
Total scores	31 (29–33)	30 (28–33)	−2.18	0.029*

IQR interquartile range

*P significant if ≤ 0.05

Conclusion

The multifactorial fall prevention program, including shared primary and secondary health care with home-based hazard modification and exercise interventions reduced the frequency of falls and improved functional performance, muscle strength and walking abilities for community-dwelling older adults at 1-year follow-up. A randomized controlled study is required to confirm the effect of the program. The results of the present study could not be generalized because the study sample involved those attending primary care and was not representative of all community-dwelling elderly populations.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical considerations The study protocol was approved by Suez Canal University Research Ethics Committee with reference no. 802. All procedures were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The aim of the research was explained to the participants and their informed consents obtained.

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