Chapter 3

Effect evaluation of a multifactor community intervention to reduce falls among older persons

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Abstract

Study Objective
To evaluate the effectiveness of a multifactor and multimethod community intervention program to reduce falls among older persons by at least 20%.

Design
In a pretest–posttest design, self-reported falls were registered for 10 months in the intervention community and two control communities. After the pretest registration, participants followed the intervention program for 14 months. The program included: Information and education, Training and exercise and Environmental modifications.

Setting
All communities were situated in the Province of Friesland in the north of the Netherlands. The study ran from November 1999 to November 2002.

Participants
The participants (intervention: 1122; control: 630) were aged 65 and older and lived independently in the community.

Main Results
There was only a significant decrease exceeding 20% in falls outside the home, among women (OR=.54, 95%CI= .30-.98; p=.041).

Conclusions
The multifactor intervention program did not decrease falls with 20%; only falls outside the home among women were reduced.

Introduction

One in three people aged 65 or older living in the community fall at least once a year.[1-3] While most of these falls do not result in serious injury that requires medical attention, they can affect quality of life because people are frightened of falling again and tend to restrict their activities.[4] On a national level, however, falls have serious implications for healthcare resources. In The Netherlands, with 2.2 million older adults aged 65 and older, the annual direct medical costs of falls amount to about 370 million Euro.[5] As the population ages, these costs will increase if no effective prevention programs are developed and implemented.

As a general proposition, it can be stated that at the time of a fall, one or more risk factors contributed to a situation in which the person, without intention, lost control over his or her body posture due to lack of capability to resist external forces (demands).[6] Multiple factors associated with health, environment, and behavior (physical activity) influence the balance between demands and capability, and for this reason a multifactorial intervention approach would seem the most promising approach to preventing falls.[7-9] Interventions that appeared effective, targeted the people at risk (for instance, people aged 75 and older[10]) and included exercises to increase mobility, strategies to reduce use of psychotropic medication, and home assessment and modification.[8] These elements were included in the design of the multifactorial community-based intervention program called: 'Safety in your own hands' for people aged 65 and older that was implemented in the town of Sneek in the Netherlands.[11] The effectiveness, the reduction of falls or the number of persons who fell down, was evaluated in the study.

Only a few studies have evaluated the effectiveness of interventions in preventing falls in a community-based approach.[12-14] All these studies used hospital data to evaluate the interventions;[12] additionally used self-report information. The studies yielded mixed results. Poulstrup et al.[13] reported a decrease in fall-related lower extremity fractures among women but not among men. Ytterstad[14] found a decrease in fall-related fractures occurring at home among women, and a decrease in fall-related fractures outside the home among men in traffic areas. Kempton et al.[12] found a non-significant 22% decrease in self-reported falls and a significant ($p<.001$) 20% lower fall-related hospitalization rate among both men and women. Based on these findings, the Area Health Authority Fryslân, who initiated the program, aimed to achieve a 20% reduction in falls or persons who fell down inside and outside the home. The effectiveness of the intervention was evaluated in a community intervention trial[15] performed from 1999 to 2002, involving the intervention community (Sneek) and two control communities.

Methods

Subjects and setting

All inhabitants aged 65 and older living independently in Sneek were the target group for the intervention (n=4,369). They were invited to participate in the study. Two control communities (Harlingen, Heerenveen) were suggested by the Area Health Authority Fryslân based on their knowledge of general characteristics. Both control communities were located about 25 kilometers from the intervention community. The total number of inhabitants ranges from 16,000 (Harlingen), 33,000 (Sneek) to 40,000 (Heerenveen); the proportion of persons aged 65 years and over ranges from 13% (Sneek) to 15% (Harlingen, Heerenveen). The average number of inhabitants in the intervention and control communities is about 1000 per km^2. Per 10,000 inhabitants, 5 general practitioners are available in each community.

Study design and procedure

In a pretest–posttest design, self-reported falls were registered in the intervention and control communities for 10 months. In Sneek all 4,369 persons (41.5% male) aged 65 years and over and living independently received a questionnaire and were asked to participate in the study. The same questionnaire was send to 4381 persons in the control communities in the same age category (40.6% male) and living independently. They were randomly selected from the civilian's registry office and asked to participate.

The pretest registration procedure started in November 1999. All participants received a brief written instruction about how to answer a monthly phone call. Subsequently, they were telephoned each month for 10 months and asked, by the Telephone Inquiry System (TIS), an interactive voice response computer, whether they had fallen in the previous month.[16] Those who reported a fall were subsequently telephoned personally and were interviewed about the circumstances and consequences of the falls.

After the pretest registration period, a 14 months preventive intervention program was implemented in Sneek. The posttest registration started after the 14 months intervention period and took 10 months.

Measurements

Outcome variables were the fall incidence and number of people who fell down at least once per 1000 persons per year (the period prevalence of fallers), categorized by sex and location of the fall (inside, outside the home). The results are presented for men and women separately because of the sex-related differences in falls in other studies. The location of the fall (inside, outside the home) was investigated because

of the mixed results reported by Ytterstad (1996)[14]. Both measures were used in previous studies on falls[2, 7, 17].

The questionnaire administered at baseline included questions about demographic characteristics: sex, age, marital status (married, divorced, widowed, never married), education (primary, secondary, higher), number of people in the household, type of house (all rooms on the same floor, rooms on different floors). Health-related questions were also included, namely, subjective evaluation of general health (fair, moderate, bad), chronic diseases, and medication use (yes, no). Disability was measured with the OECD disability indicator[18]. Respondents were also asked about the frequency of fear of falling inside and outside the home (never, seldom, regular), use of walking aids inside and outside the home (walking stick, walking frame, rollator, wheelchair, electric medical scooter). Lastly, in order to estimate the level of outdoor physical activity, respondents were asked about the frequency of walking and bicycling during summer and winter (daily, once/twice a week, once/twice a month, seldom or never)[11].

In the personal telephone interviews, information was obtained about the location of the fall (in the home, outside the home). The procedure and measurements were approved by the TNO Medical Ethics Testing Committee in Leiden.

Intervention and control conditions

The intervention was developed and implemented by private and public health and welfare organizations in the Province of Friesland and in Sneek. A steering committee was chaired by the Area Health Authority Fryslân. The intervention included different activities: Information and education; Training and exercise of older persons, volunteers and homecare professionals; and Environment modifications, as presented in table 1. Some aspects of the intervention focused directly and indirectly (through professionals) on a specific group of individuals at risk of falls, namely, people older than 75 years and living independently. Topics of relevance to fall prevention were home assessment and modification, mobility training, and psychotropic medication reduction, as recommended by Gillespie et al. (2003)[8]. Traffic safety, especially related to bicycling, was included because many older people ride a bicycle in the Netherlands and falls from bicycles are common[11].

Table 1 *Description of the intervention activities*

Topic	Aim	Target groups	Mode (s)	Exposure
Information and Education (IAE)				
Aim, content and scope of the project	Raising general awareness of project	All older people, their relatives and professionals working with older people, e.g.: General Practitioners, Pharmacists, Hospital, Library, Physiotherapists, Homecare .	Information market. Leaflets, poster, fall risk profile. Newspapers, Joumals Exposition fall prevention	Once; 450 visitors Permanent 32 publications 5 months
		Older people as members of clubs, and other organizations. Medical staff of hospital and GP's.	Presentation at regular meetings Clinical lesson	13 presentations; 300 visitors Once; 30 Specialists, 20 GP's
Home safety	Raising awareness of risks in the home	All older people	Checklist home safety Newspaper articles	Permanent available 4 articles
	Identifying risk factors in the home and offering solutions	Older people 75+	Home visits by trained safety consultants	200 visits
Physical activity	Informing people about importance of mobility training	All older people	Leaflets Course Newspaper articles	 4 courses; 171 participants 7 articles
Medication	Informing people about risks of sleeping pills and tranquilizers	All older people	Leaflets presented at 12 offices of general practitioners and pharmacists. Newspaper articles	12 x 50 = 600 leaflets 3 articles
Traffic safety	Improving knowledge about traffic rules and safety	Older people involved in traffic	Course Newspaper articles	6 courses; 227 participants 5 articles
	Bicycle safety	Older people that ride bikes	Newspaper articles	7 articles
Training and exercise				
Home safety	Identifying risks in the home environment	Professionals working in the home care	Training course	Once; 160 participants
		Volunteers from peer group of older people performing home visits	Training course	Once; 15 participants
Balance training	Prevention of falls	All older people	Training course: In balance, based on Tai Chi	31 participants
			Training course: Ageing Well and Healthily	20 particpants
Traffic safety	Improving biking skills	Older people that ride bikes	'Biking day'	150 visitors, 35 biking participants
Environmental modifications				
Home safety	Modifying the home environment	Older people asking for assistance	Team of technicians offering assistance	15 requests
Safe pavements in the community	Removing obstacles from pavements	All older people	Telephonic reporting desk for obstacles on pavements	5 working days a week

The aim of the information and educational activities was to raise general awareness of the project and of the risk of falls among older people and professionals working with older people in the community. Specific events were organized (such as an information meeting, presentations at meetings of local organizations, clinical lesson), leaflets and posters were developed, articles were published in local newspapers and magazines, and there was a mobile exhibition about fall prevention. A fall risk profile was developed on the basis of 11 relevant risk factors from the literature.[19] This helped to make people aware of their fall risk. Information about home assessment and modification was provided by means of a leaflet containing a checklist specially designed for use by older individuals. In addition, 15 volunteer safety consultants, who were themselves older individuals, were trained to visit people at risk (aged 75 and older) in their homes, to assess the safety of the home and to mention potential safety issues. They also discussed medication use and the importance of physical activity, mentioning the possibility to attend mobility training. Leaflets on the benefit of physical activity and mobility training for fall prevention, the risk of falls in association with the use of sleeping pills and tranquilizers, and about traffic rules were distributed through healthcare and welfare offices. A technical team was available to help people make necessary changes in the home. They received 15 requests for help. In addition, a telephone desk for complaints about pavements was run by the Department of Public Works, which undertook to address any such reports.

Two 'In balance' mobility-training courses were given to 31 participants. People were told about the risk of falls and performed exercises (based on Tai Chi principles). Also the course 'Ageing Well and Healthily'[20] was given twice that included information and mobility training. With regard to traffic safety, a biking day was organized during which the participants' bicycles were given a safety check and then participants went for a bicycle ride. In total, 800 individuals, among whom 50 healthcare professionals and 160 homecare professionals attended one or more meetings, 10 courses were organized (attended by 398 people) and 22 articles were published in local magazines and newspapers.

In the control communities no falls prevention programs were running during the study. The Area Health Authority Fryslân, that covers the area of the intervention as well as the control communities, monitored prevention initiatives related to older persons. During the study period in the control communities the conditions related to falls prevention were not changed due to local preventive initiatives. Publications about falls prevention in the intervention community were not published in newspapers in the control communities.

Study Power

Power analysis (alpha=.05 (one tailed), 1-Beta=.80) indicated that there should be 1800 participants in the intervention and control communities. On the basis of another community study,[21] we estimated that, during a 10-month period, 10% of the participants would fall and that 20% would drop out during the study period (pretest and posttest). Also the aim of the intervention, 20% reduction, was taken into account.

Statistical Analyses

Data for respondents who participated at least 1 month in both the pretest and posttest periods were analyzed, using SPSS 10.0 for Windows. A general outdoor physical activity score was computed. For each individual, the reported outdoor physical activity (walking, bicycling in summer, winter) in the categories: each day=4, once or twice a week=3, once or twice a month=2, seldom or never=1, were summed to generate 13 outdoor physical activity levels. The highest score (16) reflects the highest outdoor physical activity. Outdoor physical activity was then categorized in three tertiles: inactive (4-10), moderately active (11-14), and active (15-16). Descriptive statistics were used to describe the main characteristics of the respondents in the intervention and control communities. The groups were compared using t-tests (for numeric data) and chi-square test. To analyze the effectiveness of the intervention, weighted difference scores were calculated based on the number of months a respondent participated. For further analysis and testing Logistic regression (period prevalence of fallers) and Analysis of Variance (incidence of falls) were used. Differences in main characteristics of participants in the intervention and control communities at baseline were taken into account by including these variables in the analysis models.

Results

Inclusion and drop out of subjects in the study

Of the 4369 people sent a questionnaire in the intervention community, 1338 (30.6%) were included in the study; in the control communities 16.9% (n=742) were included. Two hundred-sixteen people (16%) from the intervention community and 112 people from the control communities (15%) dropped out during the study. More men than women and relatively older people (80+) dropped out, but at a comparable rate in both communities. Thus, data for 1122 people from the intervention community and 630 people from the control communities were available for analysis (figure 1). With

these group sample sizes we can achieve 80% power to detect a 28% reduction of the period prevalence of fallers.

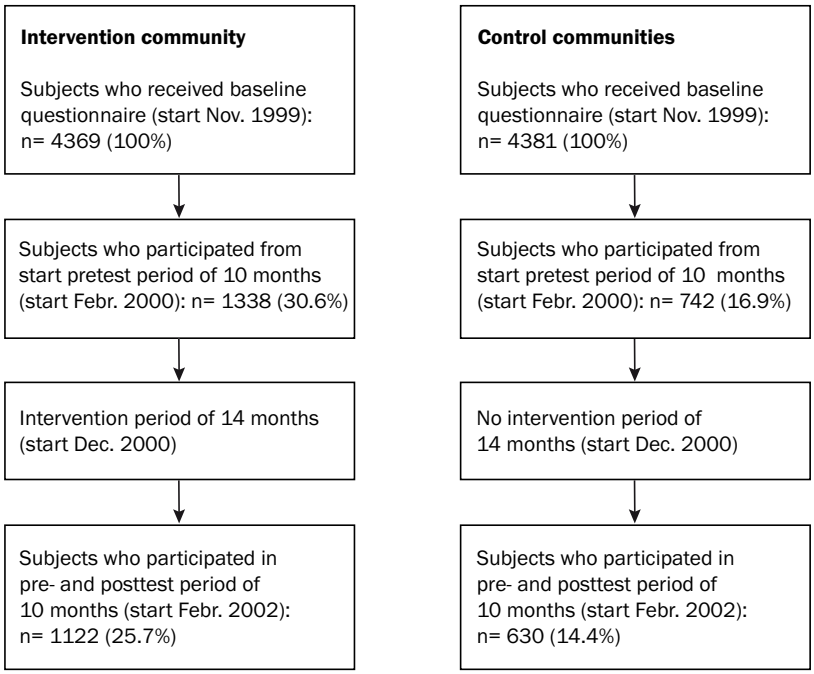

Figure 1 *Flow chart of inclusion and participation of subjects in the study*

Characteristics of subjects in the study

The main characteristics of the study participants at baseline are given in table 2. People from the control communities had, relative to the intervention group, a higher level of educational attainment, lived more often in houses with two or more floors, experienced more difficulty with transfer from chair and less often reported dizziness with falls as a health problem in the past year. The intervention community appeared to be more physical active outside the home. However, the difference was only significant for women (chi=6.1 (df=2), p=.047) and not for men (chi=2.5 (df=2), p=.282).

Table 2 *Demographic, health, and disability variables of the people included in the analysis from the intervention and control communities*

Variable	Categories	Intervention Community	Control Communities	Test statistic, P Value
N		1122	630	
Age (years)		72.6	72.9	ns*
Female		59.0%	55.8%	ns
Living alone		34.5%	32.2%	ns
Education	Primary Secondary Higher	36.0% 52.6% 11.4%	28.8% 57.4% 13.8%	chi= 9.6 (df=2), p=.008
Living situation	One floor	37.3%	26.8%	chi= 19.6 (df=1), p<.001
Subjective health	(Very) good	68.0%	65.2%	ns
Dizziness with falls	Yes	7.6%	4.5%	chi= 5.7 (df=1), p=.017
Regular fear of falling	Inside the home Outside the home	16.7% 22.6%	15.6% 20.6%	ns ns
Disability (Yes)	Face recognition at 4 meters Carrying object of 5 kilograms for 10 meters Bending Walking 400 meters Dressing Transfer from bed Transfer from chair Stair climbing Performing demanding household activities	11.0% 36.6% 31.4% 24.3% 6.3% 6.1% 9.7% 25.6% 45.2%	10.1% 36.1% 32.5% 27.7% 9.0% 6.9% 12.8% 29.1% 46.6%	ns ns ns ns ns ns chi= 4.0 (df=1), p=.046 ns ns
Use of any walking aid	In the home Outside the home	15.9% 19.2%	17.8% 23.0%	ns ns
Outdoor physical activity level (walking, bicycling)	Active Moderately active Inactive	29.9% 37.6% 32.5%	25.0% 36.7% 38.3%	chi=7.1 (df=2), p=.028

*ns= non-significant two sided test p>.050

Pretest registration of falls in the community

Pretest, the weighted period prevalence of fallers was 145 in the intervention community (some persons were involved in falls in and around, as well as outside the home) and 134 in the control communities. The related weighted incidence rate of falls was 226.3 and 203.9 for the intervention and control communities, respectively (table 3).

Table 3 *Weighted number of people involved in at least one fall (period prevalence of fallers) and number of falls per 1000 persons per year by sex and domain of falls for the intervention and control communities by pretest and posttest registration periods*

Type of accident		Intervention community		Control communities		Test result*
Falls in and around the home		Pretest	Posttest	Pretest	Posttest	
Persons involved per	Men	87.5 (32)	80.1 (25)	80.3 (17)	76.0 (16)	p=.851
1000 persons per year	Women	110.7 (54)	136.0 (65)	122.8 (31)	108.0 (27)	p=.346
(N):	All	101.3 (86)	113.7 (90)	104.3 (48)	94.1 (43)	p=.443
Incidence of falls per	Men	140.7 (39)	95.4 (27)	143.7 (18)	99.9 (18)	p=.680
1000 persons per year	Women	171.9 (67)	175.0 (72)	170.4 (33)	158.6 (36)	p=.972
(N):	All	159.3 (106)	142.9 (99)	158.8 (51)	133.1 (54)	p=.892
Falls outside the home						
Persons involved per	Men	34.8 (12)	63.3 (21)	31.2 (6)	52.9 (11)	p=.278
1000 persons per year	Women**	59.1 (29)	65.1 (32)	28.0 (7)	103.4 (27)	p=.041
(N):	All	49.2 (41)	64.3 (53)	29.4 (13)	81.5 (38)	p=.279
Incidence of falls per	Men	52.3 (13)	93.6 (23)	43.7 (6)	68.4 (12)	p=.303
1000 persons per year	Women	76.9 (30)	81.3 (35)	46.2 (8)	114.4 (28)	p=.111
(N):	All	67.0 (43)	86.3 (58)	45.1 (14)	94.4 (40)	p=.663

* Logistic regression for persons involved, analysis of variance for incidence, corrected for education, living situation, diziness with falls, transfer from chair and outdoor physical activity level (walking, bicycling)
** OR=0.54, 95% CI= (.30-.98)

Falls and outdoor physical activity at baseline

At baseline, the weighted period prevalence of fallers for Men, Women and All, did not differ significantly between the intervention and control communities; neither for falls in and around the home nor for falls outside the home (chi-square tests with all $p > .050$), and when corrected for education, living situation, dizziness with falls, transfer from chair and outdoor physical activity level (walking, bicycling) with all $p > .050$.

The level of outdoor physical activity appeared to be positively related to the period prevalence of fallers outside the home and negatively related to the period prevalence of fallers inside the home at pretest as shown in table 4.

Table 4 *Period prevalence of fallers inside the home and outside the home by level of outdoor physical activity*

Outdoor physical activity (walking and bicycling)				Test result
Period prevalence of fallers*	**Inactive**	**Moderately active**	**Active**	**Logistic regression**
Inside the home	125.1	108.9	64.2	OR= .72 95% CI= .57- .91, p= .007
Outside the home	23.5	54.6	52.4	OR= 1.44 95% CI= 1.02- 2.03, p= .039

* per 1000 persons per year

Effectiveness of the intervention

For analysis, the pretest and posttest results were adjusted for significant differences in characteristics at baseline of the persons between experimental and control communities as presented in table 2.

The intervention did not significantly reduce the period prevalence of fallers or the number of falls per 1000 persons per year relative to control. However, there was a significant relative reduction exceeding 20% in the period prevalence of fallers outside the home, and especially among women (OR=.54, 95%CI=.30-.98; p=.041). The relative reduction was mainly due to a strong, about three to fourfold, increase in the period prevalence of women who fell in the control communities in the post intervention period. In contrast, the period prevalence of women in the intervention community who fell was not different before or after the intervention.

No relation was found between the increase in age of the participants and the increase in the incidence of falls between the pre- and posttest periods (OR=1.01, 95% CI= .97- 1.04; p>.050).

Discussion and conclusions

Persons aged 65 years and older, living independently in the community, took part in a multifactorial and multimethod community-based intervention aimed to achieve a 20% relative reduction in the period prevalence of fallers and in the number of falls. The results show that the aim of the intervention was not achieved; therefore the intervention is not regarded as effective.

The intervention included information and education, training and exercise and environmental modifications related to home safety, physical activity, medication use, and traffic safety. It included therefore the combination of intervention elements

that were effective in reducing falls in other studies.[8] However, in practice only few people took part in balance training and few requests for assistance with modifying the home were received (table 1). The best received aspects of the intervention were those concerning Information and Education activities aimed at raising awareness of the risk of falling among older people and professionals and related risk factors like medication use. For this reason, the main impact of the intervention was on these aspects. The lack of participation in advised interventions that we found is recently studied by Yardley et al.[22] They conclude that falls prevention advice among older persons was typically regarded as useful in principle, but not personally relevant or appropriate. Advice about falling was often depicted as common sense, only necessary for older or more disabled individuals, and potentially patronizing and distressing. Therefore the willingness to participate actively in preventive interventions is generally low. Yardley et al.[22] suggest that messages that focus on the positive benefits of improving balance may be more acceptable and effective than advice on falls prevention.

For the effect evaluation of the intervention, a pretest–posttest design was chosen to correct for a possible 'natural' variation in fall incidence between the pretest and posttest period, for instance due to aging of the persons involved in the study or seasonal variation.

Although the aim of the intervention was not achieved, the effect evaluation shows a selective relative reduction in falls outside the home among women only. While the period prevalence of fallers did not increase for women from the intervention community, it did for women of the control communities. Although not statistically significant, among men in the intervention as well as the control communities, a tendency towards an increase in outdoor falls is also observed, indicating a general trend towards increased outdoor falls in the post intervention period.

Due to lack of data related to the post intervention period, we can not explain from our study why the relative reduction of the period prevalence of fallers, especially among women, is observed.

However, a selective reduction in falls for women in community-based intervention studies was also reported by other authors.[13,14] On the basis of hospital data, these studies reported a reduction in fracture rates due to falls among women only. The authors suggested that women may be more receptive than men to a fall prevention intervention. Other studies suggest a mechanism that might help to explain of our findings, although more research is needed to be conclusive about its

appropriateness. Schoenfelder et al.[23] found that information about risk factors for falls raised risk awareness and concern about falling among women in particular. It has been suggested that people who are worried about falling limit their activities, especially outside the home, to reduce the fall risk.[24-26] In their studies, Kempton et al.[12] and Hahn et al.[27] explained the reduction in physical activity as being due to people following the often-given advice to 'take it easy' when they raise the issue of falling among relatives and their doctors.

The phenomenon that persons reduce physical activity (reduce demands) as a behavioral response to increased perceived task difficulty (due to information about risk factors for, and possible consequences of falls) is in agreement with the task difficulty homeostasis theory.[28] This theory describes the behavioral response of persons in order to balance perceived demands and capabilities in order to prevent loss of control (in this context the loss of control of body posture). This mechanism may have reduced the participation in outdoor activities by older women in the intervention community, because they were most sensitive to the information about the risk of falling.

Based on crossectional data in our study, a relative low level of participation in outdoor physical activity appeared to be associated with reduced outdoor falls. However, at the same time a relative low level of outdoor physical activity was associated with an increased involvement in falls in and around the home; for instance because the persons spend more time at home. These associations may in part indicate why outdoor falls were reduced, while falls in the home did not decrease among women after the intervention.

An important limitation of the study is that participants were not randomly allocated to an intervention or control group. The community approach that was applied did not leave the opportunity for individual randomization because many interventions were presented to all older inhabitants of the intervention community. The selected design, including the two control communities, leaves open the possibility of unknown confounders that influence the results. By taking into account all differences in baseline characteristics of persons in the intervention and control communities during the analysis, the influence of confounding was reduced. A weakness related to this issue is that we did not measure changes in factors that are related to accident risk, such as the level of physical activity of the participants. The main reason for this omission is that the funding of the study was not sufficient for including these measurements. As a result, we are not able to explain the increase in the period prevalence of fallers outside the home in terms of changes in exposure to specific risk factors for different groups. Increased age (participants were about 2 years older

in the posttest period) was not associated with the increased incidence of falls. It remains to be established more decisive to what extend the assumed decrease in outdoor physical activities is a consequence of information and education about the risk of falls. Future studies should therefore measure changes in the level of physical activity of participants.

Another weakness of our study is the high drop-out rate, which reduced the power of the study. The high drop-out rate could be the consequence of the long follow-up period, about 3 years with a break of 14 months, and the old age of the participants. However, despite the drop out, at baseline both intervention and control communities did only differ significantly on a limited number of respondent characteristics. For these differences was controlled during analysis.

The results showed that the multifactorial intervention was not effective to achieve the 20% falls reduction and only reduced the period prevalence of fallers outside the home among women. It is suggested that the mechanism involved is that these women reduced their outdoor physical activity compared to the other persons involved in the study. Future follow-up studies should assess to what extent people change their level of physical activity both in and outside the home as a result of prevention interventions. These data can provide insight into the way older people modulate the balance between task demands and performance capability in order to cope with their perceived risk of falling.

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