Randomised factorial trial of falls prevention among older people living in their own homes

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Abstract

Objective To test the effectiveness of, and explore interactions between, three interventions to prevent falls among older people.
Design A randomised controlled trial with a full factorial design.
Setting Urban community in Melbourne, Australia.
Participants 1090 aged 70 years and over and living at home. Most were Australian born and rated their health as good to excellent; just over half lived alone.
Interventions Three interventions (group based exercise, home hazard management, and vision improvement) delivered to eight groups defined by the presence or absence of each intervention.
Main outcome measure Time to first fall ascertained by an 18 month falls calendar and analysed with survival analysis techniques. Changes to targeted risk factors were assessed by using measures of quadriceps strength, balance, vision, and number of hazards in the home.
Results The rate ratio for exercise was 0.82 (95% confidence interval 0.70 to 0.97, P=0.02), and a significant effect ($P < 0.05$) was observed for the combinations of interventions that involved exercise. Balance measures improved significantly among the exercise group. Neither home hazard management nor treatment of poor vision showed a significant effect. The strongest effect was observed for all three interventions combined (rate ratio 0.67 (0.51 to 0.88, P=0.004)), producing an estimated 14.0% reduction in the annual fall rate. The number of people needed to be treated to prevent one fall a year ranged from 32 for home hazard management to 7 for all three interventions combined.
Conclusions Group based exercise was the most potent single intervention tested, and the reduction in falls among this group seems to have been associated with improved balance. Falls were further reduced by the addition of home hazard management or reduced vision management, or both of these. Cost effectiveness is yet to be examined. These findings are most applicable to Australian born adults aged 70-84 years living at home who rate their health as good.

Introduction

The prevention of falls among older people living in their own homes is an established priority in many countries. Randomised trials of single interventions among older people living at home have shown that exercise,[1] medication reduction,[2] support services arranged by trained volunteers,[1] and home modifications arranged by occupational therapists[3] are all effective interventions. Trials of multiple interventions among older people living at home have also shown reductions in the risk of falling.[1]

None of the designs of these trials, except one,[2] permitted examination of the effects of each component separately or of any interactive effect between components. The main aim of this randomised controlled trial was to test the effectiveness of, and to explore any interactions between, three interventions to reduce falls among older people.

Methods

Setting and subjects

The study was conducted in the City of Whitehorse, a mainly middle class area of Melbourne, Australia. Potential participants were people aged 70 years and over living in their own home.

Design

The targeted risk factors were strength, balance, poor vision, and presence of home hazards. A full factorial design was used, with eight distinct groups (including a control) defined according to the presence or absence of each of the three interventions (fig 1). The control group received no intervention until after the study had ended.

Inclusion and exclusion criteria

Participants had to be living in their own home or apartment or leasing similar accommodation and allowed to make modifications. Potential participants were excluded if they did not expect to remain in the area for two years (except for short absences); had participated in regular to moderate physical activity with a balance improvement component in the previous two months; could not walk 10-20 metres without rest, help, or having angina; had severe respiratory or cardiac disease; had a psychiatric illness prohibiting participation; had dysphasia; had had recent major home modifications; had an education and language adjusted score > 4 on the short portable mental status questionnaire[4]; or did not have the approval of their general practitioner.

Recruitment

We sent invitation letters and made follow up telephone calls to 11 120 people aged 70 years and over and registered on the Australian electoral roll for the area. The electoral roll includes almost all older people.

Assessment

Participants received a home visit by a trained assessor, who was initially blinded to group assignment. After informed consent was obtained, a baseline questionnaire was completed covering demographic characteristics; ability to perform basic activities and instrumental (more complex) activities of daily living[5]; use of support services; social outings and interests; the modified falls efficacy scale[6]; self rated health; and falls and medical history. Current prescription and over the counter drugs were recorded from containers at the participants' homes. Finally, the targeted risk factors (strength, balance, vision, and home hazards) were assessed (see table 1 in the full version of this article on bmj.com). Participants were then assigned (by computer generated randomisation) to an intervention group by an independent third party via telephone.

After 18 months, the risk factor assessments were repeated in a proportion of participants (n=442) randomly selected by an assessor blinded to the intervention group (we used only a proportion of the participants because resources to reassess the whole study group were not available and this assessment was of secondary importance to the study's main goal). Strength and balance were also measured at the final exercise class of the first 177 participants to complete the 15 week programme, 79 of whom were among the 442 subsequently selected for final reassessment.

Interventions

We sent all participants a letter outlining their assigned interventions, advising of necessary actions.

Strength and balance—Participants attended a weekly exercise class of one hour for 15 weeks, supplemented by daily home exercises. The exercises were designed by a physiotherapist to improve flexibility, leg strength, and balance, and 30-35% of the total content was devoted to balance improvement. Exercises could be replaced by a less demanding routine, depending on the participant's capability. Transport was provided where necessary.

Home hazards—Home hazards were removed or modified either by the participants themselves or via the City of Whitehorse's home maintenance programme. Home maintenance staff visited the home, providing a quotation for the work, including free labour and materials up to the value of $A100 (£37; $54; €60).

Vision—If a participant's vision tested below predetermined criteria and if he or she was not already receiving treatment for the problem identified, the participant was referred to his or her usual eye care provider, general practitioner, or local optometrist, to whom the vision assessment results were given. Participants not receiving the vision intervention were provided with the Australian Optometrist Association's brochure on eye care for those aged over 40.

Outcome measures

Participants reported falls using a monthly postcard calendar system to record daily falls outcome. Participants not returning their calendar within five working days of the end of each month, and those recording a fall, were followed up by telephone by a research assistant blinded to group assignment.

Analyses

We calculated changes in levels of risk factor by comparing measures at baseline with those at the end of the study for the 442 randomly selected participants. We calculated mean scores for each of the measures. Analysis followed the main effects model such that those who were assigned a particular intervention were compared with those who were not—for example, exercise versus no exercise.

We analysed the time from randomisation to a participant's first fall using Cox's proportional hazards model. Effects on the annual fall rate were estimated within the Cox model, confidence intervals being determined using the bootstrap method.

All analyses were performed on an intention to treat basis.

Results

A total of 1107 participants received a baseline assessment and group assignment (fig 1). Demographic characteristics and baseline risk factor measures in the eight study groups were similar. The distribution of group assignment among the 442 participants who were randomly selected for reassessment was representative of the combined study group, and demographic characteristics and baseline risk factor measures were similar to those of the combined study group.

Falls outcome

The three main interventions did not interact so only results based on a main effects model are reported. Figure 2 shows the Kaplan-Meier curves for the intervention and non-intervention groups for the three main effects separately. There was a significant benefit for exercise alone, and a significant effect ($P < 0.05$) for all interventions in which exercise was combined with other interventions (table). The strongest effect was observed for all three interventions together.

Risk factors for falls

The measures of strength and balance undertaken at the final exercise class of the first 177 participants showed significant improvements in mean number of errors made during coordinated stability testing (12.2 *v* 9.7, $P < 0.001$) and in maximal balance range (13.3 cm *v* 15.1 cm, $P < 0.001$). Quadriceps strength improved in weaker legs (18.7 kg *v* 23.6 kg, $P < 0.001$) and stronger legs (21.9 kg *v* 24.6 kg, $P < 0.001$).

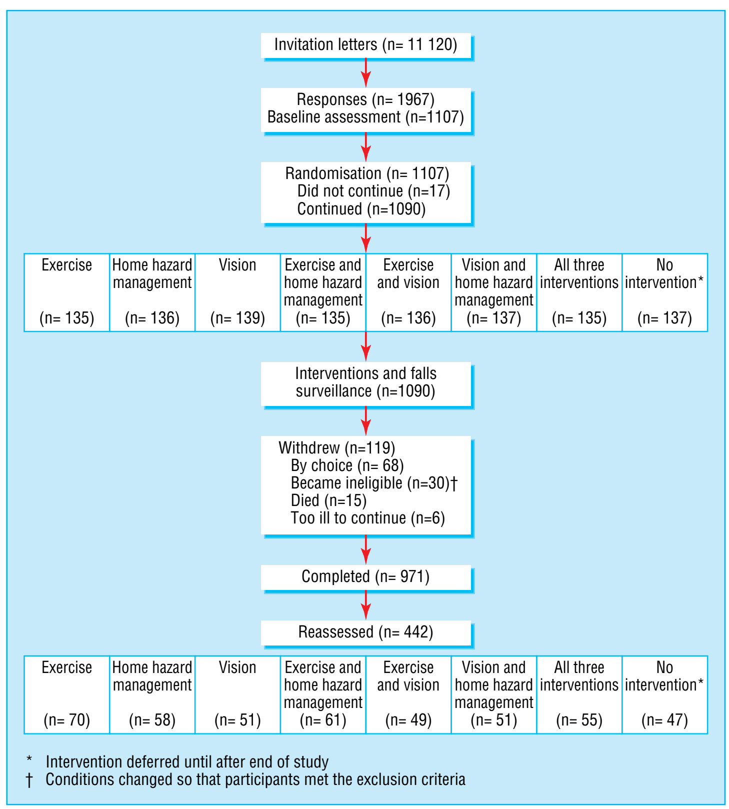

Figure 1 Flow chart showing stages in study protocol and numbers of participants

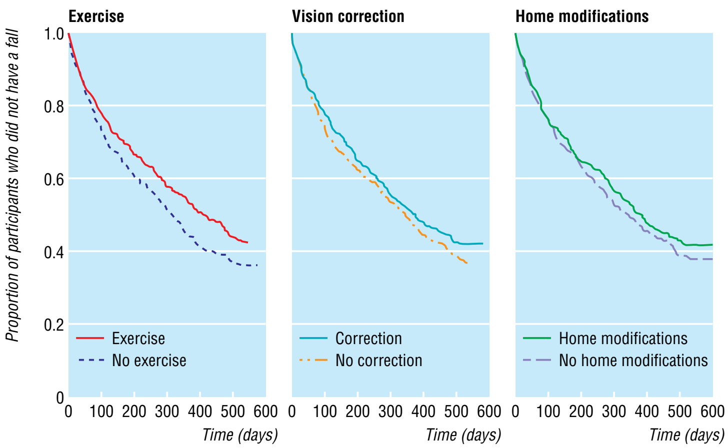

Figure 2 Kaplan-Meier plots showing the probability of remaining fall-free, for each of the three interventions separately. All participants are represented in each of the three graphs

After 18 months, maximal balance range showed little change in the participants receiving the exercise intervention (decrease of 0.64 cm from mean of 13.7 cm) but decreased over time among the control group (decrease of 1.8 cm from mean of 13.6 cm) (P=0.01). This suggests that the exercise intervention slowed the rate of age related deterioration. There were no other significant improvements in the strength and balance measures.

The mean average number of hazards in the participants receiving home hazards intervention decreased from 10.2 to 7.4, compared with a decrease from 9.1 to 7.9 in the control group (P<0.001). Visual acuity (high contrast) improved marginally among the non-intervention group (difference in mean value of 0.046) but remained largely unchanged in the intervention group (P=0.03). No other differences were seen in the vision measures.

Discussion

We did not find an interactive effect of the interventions on falls outcome; rather, the interventions were additive. A study of withdrawal from psychotropic drug treatment combined with exercise also found no interactive effect.[2]

Unlike most previous studies of exercise among unselected older people living in their own homes,[1] these results show that a supervised exercise programme for this group for one hour a week for 15 weeks, supplemented with home exercise for up to 12 months, can reduce falls. The reduction occurred despite relatively poor compliance with the home exercise sessions (see bmj.com), which were intended to be daily, but in fact were performed twice weekly on average. This is the shortest programme of the lowest intensity shown to reduce falls. A greater reduction in falls has been shown in other programmes with more intense exercise regimes.[2 7 8]

The limited effect of the other two interventions on falls outcome may be partly related to insufficient intensity of the interventions.

As the participants differed somewhat from the general older population living at home (see bmj.com), the findings are most applicable to older adults living at home with similar characteristics—namely, Australian born, aged 70-84, and rating their health as good to excellent. Other complementary trials may be needed to examine the effectiveness of falls interventions among people living at home who are aged over 85, in poorer health, or from non-English speaking backgrounds.

The combined effect of all three interventions produced the largest falls reduction, with the exercise intervention making the greatest contribution. The falls reducing effect of this intervention was associated with improved balance. Exercise programmes that promote balance should be considered for wider implementation among older people living at home.

Cost effectiveness studies of exercise and other successful interventions would provide important information on which to base resource allocation for the prevention of falls among older people living at home.

What is already known on this topic

Multiple interventions are known to prevent falls among older people, but the relative importance of the different strategies is unknown

What this study adds

A weekly exercise programme focusing on balance, plus exercises at home, can help to prevent falls among Australians aged 70 years and over living at home and in good health

Home hazard management and vision screening and referral are not markedly effective in reducing falls when used alone but add value when combined with the exercise programme

Effect on falls outcome, single and combined interventions

Intervention	No (%) having at least one fall	Rate ratio: Estimate (95% CI)	Rate ratio: P value	% estimated reduction in annual fall rate (95% CI)	No needed to treat to prevent 1 fall
No intervention*	87/137 (63.5)	Reference (1.00)			
Exercise	76/135 (56.3)	0.82 (0.70 to 0.97)	0.02	6.9 (1.1 to 12.8)	14
Vision	84/139 (60.4)	0.89 (0.75 to 1.04)	0.13	4.4 (−1.5 to 10.2)	23
Home hazard management	78/136 (57.4)	0.92 (0.78 to 1.08)	0.29	3.1 (−2.0 to 9.7)	32
Exercise plus vision	66/136 (48.5)	0.73 (0.58 to 0.91)	0.01	11.1 (2.2 to 18.5)	9
Exercise plus home hazard management	72/135 (53.3)	0.76 (0.60 to 0.95)	0.02	9.9 (2.4 to 17.9)	10
Vision plus home hazard management	78/137 (56.9)	0.81 (0.65 to 1.02)	0.07	7.4 (−0.9 to 15.2)	14
Exercise plus vision plus home hazard management	65/135 (48.1)	0.67 (0.51 to 0.88)	0.004	14.0 (3.7 to 22.6)	7

*No intervention until after the study had ended.

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Are inequalities in height underestimated by adult social position? Effects of changing social structure and height selection in a cohort study

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Abstract

Objectives To investigate whether changing social structure and social mobility related to height generate (inflate) inequalities in height.
Design Longitudinal 1958 British birth cohort study.
Setting England, Scotland, and Wales.
Participants 10 176 people born 3-9 March 1958 for whom data were available at age 33 years.
Main outcome measures Adult height and social class at age 33 years; class of origin (father's occupation when participant was 7 years old).
Results Adult height showed a social gradient with class at age 7 years and age 33 years. The difference in mean height between extreme groups was greater for class of origin than for adult class, reducing from 2.21 cm to 1.62 cm for men and from 2.18 cm to 1.74 cm for women. This narrowing inequality was due mainly to a decrease in mean height in classes I and II. This was because of the pattern of height related social mobility in which, for example, men moving into classes I and II were taller (mean 177.2 cm) than men remaining in class III manual (mean 176.1 cm) yet shorter than men with class I and II origins (mean 178.3 cm) and the relatively large number of individuals moving into classes I and II. Changes in the structure of society, seen here with the general trend of upward social mobility, have acted to diminish inequalities in adult height.
Conclusions The combination of changing social structure and height related mobility constrains, rather than inflates, inequalities in height and may lead to an underestimation of the role of childhood socioeconomic factors in the development of inequalities in adult disease.

Introduction

Inequalities in health are a key priority in public health, but there is controversy over the possible courses of action that might be taken to reduce them.[1 2] Fundamental to the question of solutions is the question of causes, and opinion has changed over recent decades as to how inequalities develop. At the time of the Black report some argued that inequalities were created by health selection—that is, social sorting linked to health—whereby individuals with poorer health are more downwardly mobile and those with better health are more upwardly mobile.[3] Alternatively, inequalities could be an artefact of social classification[3]: as class V declines in size it becomes a more extreme group and its mortality a less important social indicator. Hence, a rise in mortality relative to that of other classes might reflect a smaller group of individuals rather than greater social inequality. Both health selection and artefact of social classification were expected to inflate health differences.[3]

It is now accepted that selection and artefact are not primary explanations for inequalities in most health outcomes,[4 5] although we still know little about the strength and direction of their effect. We assessed whether changes in the structure of society (artefact) and health related social mobility (selection) generate—that is, act to inflate—inequalities in health. We based our study on adult height, which has two advantages. Firstly, shorter adult stature is a well established predictor of cardiorespiratory disease later in life in men and women[6–10] and is therefore a useful health indicator. Secondly, height has a particular value here because once adult stature is reached it changes little, at least in early adulthood, though from late middle age there is a

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Two figures illustrating the data in the tables can be found on bmj.com