Age and Ageing 2006; **35-S2**: ii55–ii59
doi:10.1093/ageing/afl088

Home environment risk factors for falls in older people and the efficacy of home modifications

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Abstract

Most homes contain potential hazards, and many older people attribute their falls to trips or slips inside the home or immediate home surroundings. However, the existence of home hazards alone is insufficient to cause falls, and the interaction between an older person's physical abilities and their exposure to environmental stressors appears to be more important. Taking risks or impulsivity may further elevate falls risk. Some studies have found that environmental hazards contribute to falls to a greater extent in older vigorous people than in older frail people. This appears to be due to increased exposure to falls hazards with an increase in the proportion of such falls occurring outside the home. There may also be a non-linear pattern between mobility and falls associated with hazards. Household environmental hazards may pose the greatest risk for older people with fair balance, whereas those with poor balance are less exposed to hazards and those with good mobility are more able to withstand them. Reducing hazards in the home appears not to be an effective falls-prevention strategy in the general older population and those at low risk of falls. Home hazard reduction is effective if targeted at older people with a history of falls and mobility limitations. The effectiveness may depend on the provision of concomitant training for improving transfer abilities and other strategies for effecting behaviour change.

Keywords: *accidental falls, environmental hazards, mobility limitations, assistive devices*

Introduction

Most households contain potential hazards such as slippery floors, inadequate lighting, loose rugs, unstable furniture and obstructed walkways [1], and many older people attribute their falls to trips or slips inside the home or immediate home surroundings [2]. In response to these observations, home safety assessment and household modifications have been suggested as integral components of falls-prevention programs [3]. However, the role of environment hazards in increasing falls risk is by no means straightforward, and neither is the amelioration of this risk by household modification. The complex interaction between an individual's physical ability and the challenges posed by their environment does not allow for a simple cause-and-effect relationship to be established. Similarly, varying levels of compliance with home safety recommendations and the confounding effects of awareness raising associated with such interventions limit the degree to which the efficacy of home hazard reduction can be demonstrated.

This review examines the role that environmental hazards play in increasing the risk of falls and evaluates the efficacy of environmental interventions to reduce falls. For risk-factor studies, we assessed case-control and prospective studies, and for intervention studies, randomised controlled trials were considered.

Home hazards as a falls risk factor

Six case-control studies have examined the association between environmental hazards and falls [4–9]. Two of these found differences in the prevalence of household hazards between fallers and non-fallers. Isberner *et al.* [6] reported that the absence of handrails and the presence of uneven floors were more common in the households of 45 older people who had fallen compared with age- and sex-matched controls. Similarly, in a study involving 2,304 older people, Fletcher and Hirdes [9] found that those who had one or more environmental hazards in their homes were more likely to have reported falling in the last 3 months. The remaining four studies, however, found no differences in home hazards between the faller and the non-faller groups [4, 5, 7, 8].

Stronger evidence regarding the role of the environment is provided by prospective cohort studies, in which household hazards are assessed first and falls are monitored subsequently over a defined period. Of the five studies published [10–14], none found household hazards to be associated with falls in primary analyses (Table 1).

Table 1. Summary of prospective studies addressing environmental risk factors for falls in community-dwelling older people

Study	Participants	Risk-factor assessment	Outcomes	Comments
Tinetti *et al.* [10]	*n* = 336, aged 75+	Standard 30-point checklist administered by trained assessor	Number of hazards not associated with falls	Secondary analysis [16] found vigorous older people more likely to have a fall associated with an environmental hazard many of which were outside the home
Nevitt *et al.* [11]	*n* = 325, aged 60+	Self-administered questionnaire	No individual items or composite scores associated with falls	Participants who reported that environmental factors interfered with ADLs had a higher rate of multiple falls in the home (OR = 3.1, 95% CI = 1.4–6.2) Secondary analysis [15] found that hallway rugs and a composite home hazard scale were significantly associated with falls in vigorous older people
Campbell *et al.* [12]	*n* = 761, aged 70+	OT assessment	Hazards not associated with falls	Majority of falls in the home occurred over normal household items
Teno *et al.* [13]	*n* = 586, aged 65+	Telephone interviews regarding presence of loose rugs or non-slip strips in bath or shower	Neither factor associated with falls	Previous stumbles and falls, poor health status and hospitalisation were identified as falls risk factors
Gill *et al.* [14]	*n* = 1088, aged 72+	Standard assessment of 13 hazards by trained nurse assessor	No consistent associations between hazards and falls	3-year follow-up for falls No consistent association after stratification according to vision, balance/gait or cognitive impairment

ADLs, activities of daily living; CI, confidence interval; OR, odds ratio; OT, occupational therapist.

Secondary analyses from two of these studies have highlighted interesting findings. Northridge *et al.* [15] re-evaluated the data from the Nevitt *et al.* study [11], classifying subjects as either vigorous or frail. Not surprisingly, they found that the frail group suffered more frequent falls. However, they also found that whereas there was no effect of environmental hazards on fall rates among frail people, vigorous people living with more environmental hazards were more likely to fall. For this group, a four-point increase on a seven-point composite home hazard scale was associated with a 3-fold increase in the odds of falling. Similarly, in a subsequent analysis of the Tinetti *et al.* study [10], Speechley and Tinetti [16] reported that environmental hazards were also more likely to contribute to falls in vigorous older people than in frail older people. However, in this study, these hazards were mostly outside the participant's homes.

Weinberg and Strain [17] have also reported that the contribution of environmental hazards to falls differs with varying health and mobility levels. In a study of over 1,400 community dwellers, they found that those with better self-rated health and those falling outdoors were more likely to attribute a fall to the surroundings. Those with poorer self-rated health and those who reported having dexterity difficulties were more likely to attribute their falls to their own limitations.

While it seems counter-intuitive that environmental hazards are more important contributors to falls in more vigorous older people, the interaction between the person and the environment may account for this. Lawton [18] has described a model of the interaction between an older person's competence and the demands of the environment. A person must have a high competence level to cope effectively in an environment with high demands, whereas a person with a low competence level will be able to cope with an environment with low demands.

In line with this concept, Chandler *et al.* [19] conducted a prospective study of 159 older men. Using a performance-based assessment tool, each subject's level of mobility was evaluated within their individual home environment. Thus, the performance score reflects the number of environmental hazards in each household and the degree to which the individual can cope with these hazards. For example, using this tool, the absence of grab rails would not be considered a hazard if the subject has no difficulty with bathroom transfers. After 6 months of falls follow-up, the performance score was found to be an independent predictor of falls, after controlling for age, cognition and degree of mobility, indicating that this approach may be addressing the individual–environment interaction.

The extent of a person's risk-taking behaviour is also an important part of the interaction between the person and their environment. It is possible that more vigorous people are more likely to take part in risk-taking behaviour involving household hazards (i.e. standing on unsafe supports to change light bulbs, etc.). Indeed, a person's attitude to risk (on a three-point scale) has been found to be associated with increased falls [20], and a 'type A behaviour pattern' has been shown to be associated with an increased risk of falling in men [21].

Finally, non-linear factors may also be at play. Studenski *et al.* [20] used a mobility screen to classify 306 people aged ≥70 years as being in one of three categories: unable to sit or stand, having poor-to-fair mobility and having fair-to-good mobility. Participants in the poor-to-fair mobility category

experienced the highest rate of recurrent falls during a 6-month follow-up period and an elevated risk score on a standardised environmental home assessment scale. In this group, a 10-point increase in environmental risk score (out of a total 100) was associated with a 23% increase in fall risk. With regard to the other groups, it seems that those who could not sit or stand were not exposed to environmental hazards and those with good mobility were better able to withstand them.

The efficacy of home modifications to reduce falls

There have now been five randomised controlled trials of home assessment and modification reporting falls as the major outcome measure (Table 2). These studies have reported inconsistent findings, with only one showing a significant reduction in falls in the primary analysis.

Two studies involved general community populations of older people. In the first of these, Stevens *et al.* [22] found that home assessment, education regarding home hazards and installation of home safety devices did not significantly reduce falls or falls injuries. The authors considered that although many subjects in the intervention group took action in response to the recommendations, this resulted in only a small number of changes—a reduction in unsafe steps by 16%, unsafe floor rugs and mats by 14%, rooms with trailing cords by 26% and unsafe chairs by 12% [23]. In addition, a number of structural hazards detected in the household assessment were not amenable to modification.

The second general community study involved 1,090 subjects aged ≥70 years and used a factorial design to assess the independent and combined effects of interventions aimed at vision improvement, home hazard reduction and group exercise [24]. The home hazard reduction intervention comprised home assessment by a trained assessor, advice, plus provision of materials and labour for providing modifications. Home hazards were significantly reduced in the intervention group. However, this did not result in a significant reduction in falls.

Three studies have targeted interventions more closely to at-risk groups. Cumming *et al.* [25] conducted a study

Table 2. Summary of randomised controlled trials addressing home hazards in community-dwelling older people

Study	Participants	Intervention	Main outcomes	Comments
Stevens *et al.* [22]	*n* = 1737, aged 70+	Home assessment by trained nurse assessor, education about home hazards and free installation of safety devices (i.e. grab rails, repair of flooring, etc.)	Not effective in reducing falls RR = 1.11 (95% CI = 0.82–1.50)	Significant but limited effect on reducing home hazards
		Compliance: 13–78%		No training component
Day *et al.* [24]	*n* = 1090, mean age: 76.1 (SD = 5.5)	Home assessment by trained assessor, advice plus provision of materials and labour for providing modifications, i.e. rails, grab bars, etc.	Not effective in reducing falls RR = 0.92 (95% CI = 0.78–1.08)	Home hazards were significantly reduced in the intervention group
		Compliance: 76%		No training component
Cumming *et al.* [25]	*n* = 530, aged 65+	Home assessment by OT and supervision of home modifications	Not effective in previous non-fallers RR = 1.03 (95% CI = 0.75–1.41)	Falls reduced to a similar degree outside the home in previous fallers
		Compliance: 19–75%	Effective in previous fallers RR = 0.64 (95% CI = 0.50–0.83)	Advice provided on safe mobility and footwear
				Home modifications may not have been the effective component of the intervention
Pardessus *et al.* [26]	*n* = 60, aged 65+	Home assessment by OT, advice regarding modifications and how to live safely with fixed hazards	Not effective in reducing falls RR = 0.87 (95% CI = 0.50–1.49)	Underpowered for falls as an outcome measure
		Compliance: not described		
Nikolaus and Bach [27]	*n* = 360, mean age: 81.5 (SD = 6.4)	Home assessment by OT and physiotherapist, advice regarding modifications, training in use of assistive devices	Effective in reducing falls IRR = 0.69 (95% CI = 0.51–0.97)	Training in the use of mobility and technical aids provided
		Compliance 33–83%	Effective in previous multiple fallers IRR = 0.63 (95% CI = 0.43–0.94)	

CI, confidence interval; IRR, incidence rate ratio; OT, occupational therapist, RR, relative risk.

among 530 community dwellers, most of whom had been recently hospitalised. The intervention group received a home visit by an occupational therapist who assessed the home for environmental hazards and facilitated any necessary home modifications. There was no significant reduction in falls in the intervention group as a whole. There was a significant reduction in the rate of falls among those who had fallen in the year prior to the study. However, falls in this group were also significantly reduced outside of the home, suggesting that the home modifications may not have been the major factor in the reduction in falls rates. Other aspects of the occupational therapy intervention, which included advice on footwear and behaviour, may have played an important role.

The study by Pardessus *et al.* [26] involved home assessment and modification in 60 people aged ≥65 years who had been hospitalised following a fall. At 1-year follow-up, there were no differences in falls rates or hospitalisation between the control and the intervention groups. The small sample size of this study suggests that it was not sufficiently powered to detect differences between the groups.

The only randomised controlled trial specifically addressing home modification that reported a significant reduction in falls was the Falls-HIT trial [27]. This study involved 361 people with mobility limitations who had recently been discharged from hospital. The intervention consisted of home assessment and recommendations in addition to training in the use of mobility aids. At 1-year follow-up, the intervention group had 31% fewer falls than the control group, with subgroup analysis revealing that the intervention was particularly effective in those with a history of multiple falls.

A number of multi-faceted falls-prevention strategies including both intrinsic and extrinsic components (including home hazard reduction) have now been assessed with randomised controlled trials. Several of these have been found to be effective [27–31] though others have not [32–4]. Using pooled data from these trials, the Cochrane review concluded that these multifactorial interventions are effective in reducing falls in older people [35]. The design of these studies, however, does not allow assessment of the effects of individual strategies or their relative contributions to the success or otherwise of the interventions. In contrast, the factorial design used in the study by Day *et al.* [24] provides a mechanism for contrasting the effectiveness of intervention strategies. As indicated above, they found that group-based exercise was effective in reducing falls whereas home hazard management and vision improvement were not.

Conclusion

Environmental hazards are implicated as a contributory factor in a large proportion of falls in older people; however, the existence of home hazards alone is insufficient to cause falls. Rather, the interaction between an older person's physical abilities and their exposure to environmental stressors appears to be more important. Taking risks or impulsivity may further elevate falls risk. Although falling rates are lower in vigorous older people than in their frailer counterparts, it has been reported that environmental hazards contribute to falls to a greater extent in older vigorous people than in older frail people. This appears to be due to increased exposure to falls hazards with an increase in the proportion of such falls occurring outside the home. There may also be a non-linear pattern between mobility and falls associated with hazards. Household environmental hazards may pose the greatest risk for older people with fair balance, whereas those with poor balance are less exposed to hazards, and those with good mobility are more able to withstand them. Reducing hazards in the home appears not to be an effective falls-prevention strategy in the general older population and those at low risk of falls. Home hazard reduction is effective if targeted at older people with a history of falls and mobility limitations. The effectiveness may depend on the provision of concomitant training for improving transfer abilities and other strategies for effecting behaviour change.

Key points

- Falls in the home result from an interaction between environmental stressors and physical abilities or risk-taking.
- Older people with fair (rather than poor or excellent) balance may be at greatest risk from household environmental hazards.
- Evidence for the effectiveness of home hazard modification varies, depending on interacting factors, as well as on the intervention methods used.
- Home hazard reduction is best targeted at those with a history of falls and limited mobility, and may require concomitant training.

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