Effectiveness of Education and Individualized Counseling in Reducing Environmental Hazards in the Homes of Community-Dwelling Older Women

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OBJECTIVES: To test the effectiveness of an education and counseling intervention on reducing environmental hazards in the homes of older women.

DESIGN: Secondary analysis from a randomized, controlled trial with two arms: fall prevention program and health education program (control). Environmental hazards were assessed at baseline and immediately posttreatment (12-weeks).

SETTING: Participants' homes.

PARTICIPANTS: Two hundred seventy-two community-dwelling women aged 70 and older at risk for falling.

INTERVENTION: The fall prevention program involved a comprehensive fall risk evaluation, exercise, education, individualized counseling, and referrals. The health education program included topics unrelated to fall prevention. With the exception of the fall risk evaluation conducted by a nurse practitioner, baccalaureate-prepared nurses carried out the interventions.

MEASUREMENTS: Summed and individual scores for hazards related to the bathroom, floor surfaces, lighting, furniture, stairways, and storage areas.

RESULTS: Environmental hazards were found in all homes, with a baseline mean ± standard deviation of 10.7 ± 2.6 total hazards and range of four to 17 hazards. Analysis of within-group changes indicated that the fall prevention group had significantly fewer bathroom, lighting, and total hazards after the intervention, whereas the health education group had significantly fewer bathroom hazards but more floor hazards. At follow-up, the fall prevention group had significantly fewer lighting hazards and total hazards than the health education group.

CONCLUSION: Education and counseling have only modest effects in helping older women make recommended home modifications. To be most effective in reducing environmental hazards, fall prevention programs may need to provide and install safety devices. **J Am Geriatr Soc 55:1548–1556, 2007.**

Key words: home modifications; aged; randomized controlled trial

Falls in the older population are increasingly recognized as a top public health concern because of their high prevalence and significant risk of injury, disability, institutionalization, and death.[1–4] One-third to almost three-quarters of falls in community-residing older adults occur at home.[5–7] Environmental hazards have been implicated in 25% to 66% of falls,[2–10] with fall risk associated with a greater number of environmental hazards in some studies.[11,12] Although the evidence related to the effectiveness of home modifications alone as a method to prevent falls has been equivocal,[9,13–19] the reduction of known risk factors for falling, such as environmental hazards, remains a recommended strategy in fall prevention programs, particularly for high-risk individuals.[19,20]

Home assessment and modifications as a sole intervention or as part of a multifactorial intervention have been tested in fall prevention trials using individual, group, and population-based approaches that vary in intensity and format.[18,21,22] Multifactorial intervention trials rarely report on environmental hazard reduction,[16] whereas sole intervention trials report hazard outcomes in a way that makes comparisons across studies difficult.[8,9,13,18,23] Reported adherence to making recommended home modifications varies enormously, from 8% to 90%.[8,9,17,24–27] In general, studies reporting higher adoption rates for making home modifications tend to be more intense (e.g., greater frequency of contact) and provide free equipment,

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installation, or both.[17] Brief contact tends to have only minimal effect on adoption of home modifications.[24,28] Given the seriousness of falls in the older population and the importance of the person–environment interaction, especially in those at greater fall risk, there is further need to identify strategies that are effective in helping older adults make recommended home modifications.

This study investigated the effectiveness of an education and individualized counseling intervention delivered by nurses in reducing home environmental hazards in a population-based sample of community-dwelling older women at risk for falling. This intervention was conducted as part of a multifactorial fall prevention trial known as the Fall Evaluation and Prevention Program. The hypothesis tested in this secondary analysis was that there would be fewer environmental hazards in the homes of participants in the fall prevention program than those in the health education program immediately after the intervention. Additional research questions addressed how many women in the fall prevention group would prioritize goals to reduce environmental hazards in an action plan developed to reduce their fall risk factors and how many would make home modifications.

METHODS

Design

This secondary analysis involved data from a randomized, controlled, single-blinded trial with two arms: a multifactorial fall prevention program (comprehensive fall risk assessment, exercise, education, individualized counseling including environmental modifications) and a health education program (control). The parent study is assessing the reduction of falls at 1 and 2 years posttreatment in community-dwelling older women at risk for falls. Participants were stratified according to age group (70–74 and $\geq$75) and randomized using a permutated block design with varying block sizes of four and six to assure that the number of participants was balanced in each treatment group. The same nurse practitioner (MM) evaluated environmental hazards at baseline and immediately after a 12-week, home-based intervention. This individual was blinded to treatment group status, and study participants were reminded not to reveal their treatment assignment during their follow-up visit. Participants received a modest honorarium ($25) after each study endpoint. The University of Minnesota's institutional review board approved study procedures, and written informed consent was obtained before data collection.

Participants

The target population was female Medicare beneficiaries aged 70 and older living independently in the Twin Cities Metropolitan Area and deemed to be at risk for falls. To be included, participants had to show evidence of postural instability on balance testing, be cognitively intact (Mini-Mental State Examination (MMSE) score $>$23),[29] have one other injurious fall risk factor (e.g., history of falling during the previous year; $\geq$3 prescription medications; sedative, psychotropic, or cardiovascular drug use; arthritis; stroke; depression; urge urinary incontinence; MMSE score 24–26; low body mass index ($<$24); mobility limitations such as self-reported limitations in walking one block, short steps, or slow gait; foot problems; nighttime sleep problems; self-reported limitations in bathing or dressing; or orthostatic hypotension), and live within a 12-mile radius of the university campus. Exclusion criteria were inability to walk 30 feet without stopping with or without an assistive device; involvement in regular exercise; unstable health or health conditions that would prohibit safe, independent exercise; and terminal illness. Participants were required to have physician clearance for exercise participation, own a telephone, be able to read and write in English, and be available for follow-up appointments.

Recruitment was accomplished by mailing invitations for study participation to a randomized sample of female Medicare beneficiaries from a list provided by the Health Care Financing Administration (now Centers for Medicare and Medicaid Services). Initial eligibility was determined through telephone screening conducted by registered nurses, with final eligibility determination made after a comprehensive baseline assessment conducted in participants' homes by a nurse practitioner.

Outcome Measure

The primary outcome measure was the total number of environmental hazards within the home. An environmental hazard was defined as the physical element in the home that posed potential fall risk. For the purposes of this study, the home was defined as the area that began immediately inside the door of the individual house, apartment, or room unit. Environmental hazards were measured by conducting a room-by-room assessment using the Home Environmental Survey (HES).[30,31] This instrument consisted of dichotomous or categorical items that describe the presence or absence of environmental hazards in six categories: bathroom, floor surfaces, lighting, stairways, storage areas, and furniture. Bathroom hazards were checked in participants' most frequently used bathroom(s). Six items were assessed: height of the toilet seat; presence of toilet and bathtub or shower grab bars; need to reach for water control and bathing supplies; and presence of nonslip surfaces. Floor hazards included 12 items that assessed presence of throw rugs, clutter, and tripping hazards (lamp extension and telephone cords, carpet folds, and holes) in the bathroom, bedroom, kitchen, and living room. Lighting hazards included eight items related to the availability of nightlights in these rooms and ease of reaching light switches. Stairway hazards included seven items: step edge visibility, illumination, light switch access, handrail availability and safety, clutter, and tripping hazard. Storage areas included four items that assessed the ease of reaching storage (e.g., too high or too low) in the bathroom, bedroom, living room, and kitchen. Five items related to furniture stability, although these were not included in the final analyses, because so few participants were found to have unstable furniture. Thirty-seven hazards from the five environmental categories were included in the data analysis.

Standardized definitions of hazards were available to guide scoring of items.[31] The HES does not provide a standardized scoring scheme for summing items; therefore, a scoring approach based on the instrument's conceptual schema was used[30] (available upon request from first

author). In previous studies, interrater reliability estimates for most assessments of environmental hazards pooled across all rooms of the house were good to excellent using trained evaluators.[31] Reliability was expected to be higher in this study because of the use of the same nurse evaluator.

Interventions

Participants in the fall prevention program and the health education program received a 12-week intervention of alternating home visits and telephone calls from four trained baccalaureate-prepared registered nurses. Both groups received a packet of materials related to their particular intervention.

The fall prevention program group received instructions on an exercise program (initiated during Weeks 1–3); an individualized fall risk profile derived from the comprehensive risk assessment conducted as part of the baseline evaluation by the nurse practitioner, which included a list of environmental hazards identified from the HES (Week 5); fall and home safety education and counseling (Weeks 5–13); and a gift of two nightlights. The fall and home safety education conducted during two home visits involved a room-by-room discussion of physical hazards using an illustration from AARP showing hazards associated with each room along with recommendations on how to make each room safer. In addition, education was provided on how to reduce behavioral hazards associated with each room and with different activities. Participants and the intervention nurses collaboratively identified an action plan based on the participants' prioritized goals for correcting a minimum of any three identified risk factors, which may or may not have included environmental hazards derived from the baseline evaluation. Action plans for the selected risk factors were reviewed during subsequent home and telephone visits with encouragement from the nurses for making changes. Reinforcement for making needed home modifications was provided in home visits and telephone calls, as appropriate, after the home visit during which they were initially discussed. Referrals were provided on where to purchase safety devices such as grab bars or reachers and where to obtain handyman services for making home modifications.

The health education group received education on topics unrelated to fall prevention (e.g., health screenings, immunizations, and records; breast and skin care; memory tips; food fads and facts; and advance directives).

Statistical Analysis

Environmental hazards are presented as item proportions, with counts summed within each hazard category, means ± standard deviation (SD) for summed scores within categories, and a total hazard score. Environmental hazards were aggregated within categories to limit the number of tests for statistical significance at baseline. Counts of environmental hazards at baseline for the two groups were compared using unpaired *t*-tests to detect differences between groups. At follow-up, the Wilcoxon signed ranks test was used to test for within group changes, and the Mann-Whitney U Test was used to determine between-group changes on the summed hazard category and total scores. Because nightlights were provided to fall prevention group participants, analyses on the lighting hazard score and the total hazard score were conducted with and without the four items that related to nightlight use.

P-values were not adjusted for multiple comparisons. A P-value $< .05$ was considered statistically significant. The parent study was powered to detect a reduction in falls over a 1-year period; the power to detect changes in environmental hazards was not estimated before these analyses. All data were analyzed using SPSS software (Version 13.0, SPSS Inc., Chicago, IL).

Written action plans were reviewed to tally the number of participants in the fall prevention group who set a goal to correct a particular environmental hazard. The number of participants who corrected hazards at follow-up was calculated.

RESULTS

Participant Enrollment, Characteristics, and Retention

Figure 1 illustrates the flow of participants through follow-up. A total of 272 women were enrolled; 137 participants were randomized to the fall prevention group and 135 participants to the health education group. Nine participants withdrew before the follow-up visit: six participants in the fall prevention group and three in the health education group. Reasons for withdrawal were health problems (n = 4), time commitment (n = 3), move out of state (n = 1), and multiple family stressors (n = 1).

Participants in the two groups were similar at baseline (Table 1). The mean age of the overall sample was 78.8 ± 5.6. The sample was predominantly white, with education beyond high school, and lived in single-family homes. Slightly less than half lived alone. The fall prevention group had slightly more participants who lived in single-family homes, and the health education group had more participants who resided in single-level condominiums or multiple-level town homes.

A baseline HES was completed on 100% of the participants (N = 272). Five participants moved before follow-up. The baseline and follow-up HES conducted in the same home environment were available for 92.7% (n = 252) of the participants, including 126 participants (91.2%) in the fall prevention group and 126 participants (92.0%) in the health education group. Reasons participants were lost to follow-up for home environment analyses are listed in Figure 1. Reasons for refusal of home inspections or inspections of certain rooms at baseline or follow-up were ill or sleeping spouse, messy room, privacy concerns, or felt assessment was unnecessary.

Baseline Prevalence of Home Environmental Hazards

Environmental hazards were found in all participants' homes at baseline, with a range of four to 17. All homes had at least four physical hazards; 18.1% of homes had four to eight hazards, 27.4% had nine to 10 hazards, and 54.6% had 11 or more hazards. The mean number of total hazards was 10.7 ± 2.6, which included 3.7 ± 1.3 bathroom hazards, 2.5 ± 1.5 floor hazards, 1.7 ± 1.0 storage hazards, and 2.1 ± 1.4 stairway hazards. The eight most frequently observed physical hazards were low toilet seat (94.7%), no toilet grab bar (87.2%), no living room night light (85.7%),

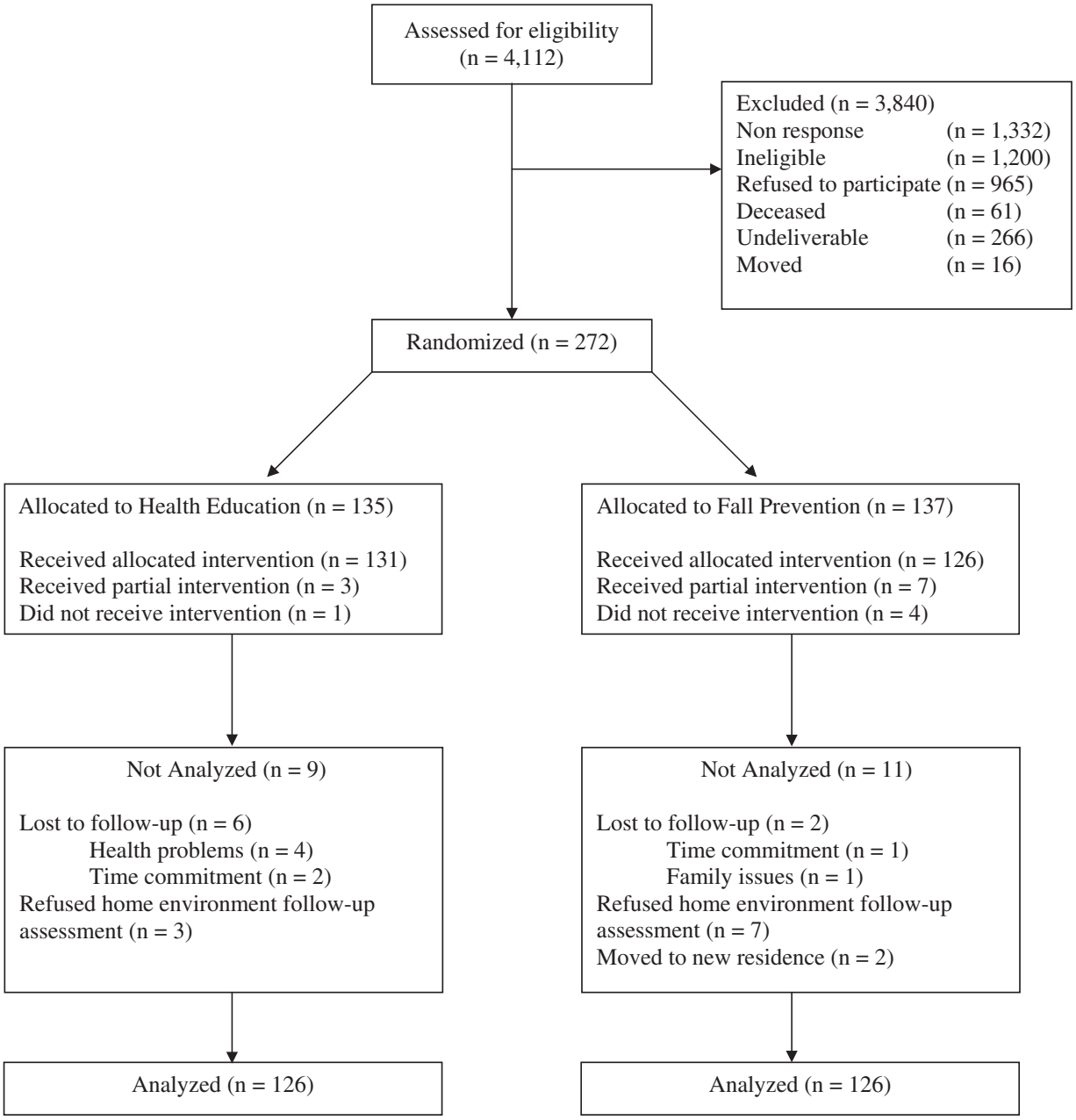

Figure 1. Flow of participants.

no bedroom night light (79.4%), bathroom throw rug (72.4%), no kitchen night light (67.5%), no bathtub or shower grab bar (60%), and throw rug in the kitchen (51.7%).

The fall prevention and health education groups had a similar number of hazards when grouped according to individual hazard categories and total number of hazards (Table 2). The one exception was that the fall prevention group had significantly more bathroom hazards ($P = .04$), which reflected having a higher proportion of homes with a slippery bathing area and no bathtub or shower grab bar.

Intervention Adherence and Effectiveness

Contact with participants in both groups during the 12-week program was similar. The fall prevention group received a mean of 6.4 ± 0.9 home visits and 5.5 ± 1.2 telephone calls, for a mean of 11.8 ± 3.1 total contacts, whereas the health education group received a mean of 6.7 ± 1.7 home visits and 5.4 ± 0.9 telephone calls, for a mean of 12.4 ± 1.8 total contacts.

Table 3 presents the findings related to changes in environmental hazards according to category within and between treatment groups for only those participants who had remained in their original homes and allowed an environmental assessment (n = 252). With respect to within-group changes from baseline to follow-up, the fall prevention group significantly reduced their hazards in two categories: bathroom ($P < .001$) and lighting ($P < .001$). They also had fewer total hazards ($P < .001$). When night lights were removed from the analyses, the fall prevention group still had a significant reduction in their total hazards

Table 1. Participant Characteristics

Characteristic	Overall Group (N = 272)	Fall Prevention Group (n = 137)	Health Education Group (n = 135)
Demographic			
Age, mean ± SD	78.8 ± 5.6	78.5 ± 0.3	79.0 ± 05.9
White, n (%)	268 (98.5)	133 (97.1)	135 (100.0)
>High school education, n (%)	163 (59.9)	85 (62.0)	78 (57.8)
Income ≥$20,000/year, n (%)*	140 (51.5)	85 (55.5)	65 (47.8)
Lives alone, n, %	133 (48.9)	68 (49.6)	64 (47.4)
Housing type			
Single-family home, n (%)	162 (59.6)	89 (65.0)	73 (54.1)
Condominium or town home, n (%)	38 (14.0)	14 (10.2)	24 (17.8)
Apartment, n (%)	69 (25.4)	34 (24.8)	35 (25.9)
Assisted living facility, n (%)	1 (0.4)	0 (0)	1 (0.7)
Clinical			
Mini-Mental State Examination score, mean ± SD†	28.5 ± 1.5	28.5 ± 1.5	28.5 ± 1.5
Fall(s) in previous year, n (%)	106 (39.0)	52 (38.0)	54 (40.0)
Injurious fall(s) in previous year, n (%)	67 (24.6)	36 (26.3)	31 (23.0)
Number of chronic conditions, mean ± SD	2.8 ± 1.6	3.5 ± 2.5	2.9 ± 1.6
Number of weekly medications, mean ± SD	3.7 ± 2.5	3.5 ± 2.5	3.8 ± 2.6
Self-reported balance problems, n (%)	85 (31.3)	47 (34.3)	38 (28.1)
Self-reported walking problems, n (%)	69 (25.4)	36 (26.3)	33 (24.4)
Use of walking device, n (%)	49 (18.0)	25 (18.2)	24 (17.8)
Good to excellent self-rated health, n (%)	251 (92.3)	128 (93.4)	123 (91.1)
Survey of Activities and Fear of Falling in the Elderly Scale score, mean ± SD‡	0.4 ± 0.4	0.4 ± 0.5	0.4 ± 0.4

* Missing data: fall prevention group (n = 15); health education group (n = 10).
† Range 0–30; score <24 indicates cognitive impairment.
‡ Range 0–3; higher score indicates greater worry about falling.[32]
SD = standard deviation.

($P = .01$). The health education group had significantly reduced their bathroom hazards ($P = .03$) but had a significant increase in floor hazards ($P = .02$) from baseline to follow-up. Removing night lights from the analysis did not modify these results. At follow-up, the fall prevention group had significantly fewer lighting hazards with night lights included ($P < .001$) and total hazards with night lights included ($P < .001$) and excluded from the analysis ($P = .047$) than the health education group.

Examination of the written action plans indicated that 69.1% (n = 85) of participants in the intervention group set at least one goal for correcting an environmental hazard. Approximately 8% (n = 10) of the fall prevention group refused to make an action plan to reduce their fall risk factors. Of those who established a plan, 55.3% (n = 47) made one or more home modifications by follow-up. The most frequent modifications made were night light installation (n = 32), removal of throw rugs (n = 12), modifying slippery bathing area (n = 8), and adding a bathing grab bar (N = 6).

DISCUSSION

The education and individualized counseling intervention led to significant, although modest, changes in lighting and bathroom hazards and total hazards in the homes of older women at risk of falling. Most of the change in environmental hazards can be attributed to the provision of night lights, a gift for study participation. The increase in floor hazards in the health education group also contributed to the change in total environmental hazards.

This study had several strengths. The use of the HES, a standardized instrument, at baseline and follow-up by a trained nurse practitioner, allowed quantification of environmental hazards and testing for group differences. Previously, only a small number of multifactorial or sole intervention trials have tested whether a program that involves home safety assessment, education, and recommendations led to group differences in fall hazards.[9,16,23,33] This group comparison is important, because there may be greater fall hazard awareness and subsequent home modifications on the part of the control group because of their participation in a fall prevention trial or from exposure to public information about fall and home safety. The current results suggest some evidence of this, because there were significant within-group changes in bathroom hazards in the control group. This is similar to two other studies that reported that the control group made home modifications.[8,25] One study reported that a large number of control group participants (74.7%) reported acting in a safer manner, with 15.8% installing safety devices.[8] The other trial found that control participants made more environmental changes than a group that received one-to-one counseling but fewer than those participating in a small-group fall

Table 2. Baseline Prevalence of Environmental Hazards (N = 272)*

Hazard	Fall Prevention Group	Health Education Group	Difference *P*-Value*
Bathroom hazards, n/N (%)*			
Low toilet seat	127/137 (92.7)	129/134 (96.3)	
No toilet grab bar	120/137 (87.6)	116/134 (86.6)	
No bathtub or shower grab bar	87/137 (63.5)	74/133 (55.6)	
Bend or reach for water control	73/137 (53.7)	60/134 (45.1)	
Slippery bathing area	76/136 (55.9)	55/133 (41.4)	
Bend or reach for bath supplies	42/137 (30.7)	36/133 (27.0)	
Total bathroom hazards, mean ± SD†	3.9 ± 1.3	3.5 ± 1.4	.04
Floor hazards, n/N (%)‡			
Throw rug bathroom	98/137 (71.5)	99/134 (73.9)	
Throw rug bedroom	39/134 (29.1)	50/133 (37.6)	
Throw rug kitchen	68/137 (49.6)	71/132 (53.8)	
Throw rug living room	44/137 (32.1)	42/134 (31.3)	
Clutter bathroom foot path	8/137 (5.8)	9/135 (6.7)	
Clutter bedroom foot path	41/134 (30.6)	28/133 (21.1)	
Clutter kitchen foot path	10/137 (7.3)	7/132 (5.3)	
Clutter living room foot path	19/137 (13.9)	9/134 (6.7)	
Tripping hazard in bathroom	3/137 (2.2)	0/135 (0.0)	
Tripping hazard in bedroom	2/130 (1.5)	3/129 (2.3)	
Tripping hazard in kitchen	1/137 (0.7)	0/135 (0.0)	
Tripping hazard in living room	1/137 (0.7)	2/134 (1.5)	
Total floor hazards, mean ± SD†	2.5 ± 1.5	2.5 ± 1.4	.86
Lighting hazards, n/N (%)			
No bathroom night light	71/137 (51.8)	72/134 (53.7)	
No bedroom night light	113/134 (84.3)	103/132 (78.0)	
No kitchen night light	92/136 (67.6)	89/132 (67.4)	
No living room night light	118/136 (86.1)	113/134 (84.3)	
Difficult to reach light switch in bathroom	1/137 (0.7)	4/134 (3.0)	
Difficult to reach light switch in bedroom	0/134 (0.0)	7/130 (5.4)	
Difficult to reach light switch in kitchen	14/137 (10.2)	9/130 (6.9)	
Difficult to reach light switch in living room	29/134 (21.6)	16/134 (11.9)	
Total lighting hazards, mean ± SD†	3.3 ± 1.2	3.1 ± 1.3	.14
Stairway hazards*			
Step edges poorly visible	65/87 (74.7)	73/85 (85.9)	
Uneven lighting of stairway	57/87 (65.5)	51/85 (60.0)	
No light switch at top or bottom of stairs	25/87 (28.7)	27/85 (31.8)	
Clutter on stairs	20/87 (23.0)	22/85 (25.9)	
Tripping hazard on stairs	1/86 (1.2)	1/83 (1.2)	
Unsafe handrail	14/78 (17.9)	13/85 (15.3)	
Absence of handrail	10/87 (11.5)	5/85 (5.9)	
Total stairway hazards, mean ± SD†	2.1 ± 1.7	2.1 ± 1.1	.73
Storage hazards, n/N (%)*			
Difficult to reach bathroom storage	31/132 (23.5)	27/129 (20.9)	
Difficult to reach bedroom storage	34/134 (25.4)	39/133 (29.3)	
Difficult to reach kitchen storage	119/137 (86.9)	111/132 (84.1)	
Difficult to reach living room storage	25/74 (33.8)	25/65 (38.5)	
Total storage hazards, mean ± SD†	1.7 ± 1.1	1.8 ± 1.0	.62
Total hazards, mean ± SD (25 items, with night lights)§	11.0 ± 2.6	10.4 ± 2.6	.07
Total hazards, mean ± SD (21 items, without night lights)§	8.1 ± 2.3	7.6 ± 2.1	.10

*Denominators vary because of refusals to allow inspections in certain areas of the home, combined rooms, lack of storage areas in room, does not use tub or shower for bathing, no stairs in home, or missing item.

†Unpaired *T*-tests.

‡Tripping hazards include lamp extension or telephone cords, carpet folds, and holes.

§Total hazards exclude stairway category, because not all participants had stairs.

n/N = number of participants with hazard/total number of participants; SD = standard deviation.

Table 3. Effects of Education and Individualized Counseling on the Reduction of Environmental Hazards

Hazard Category	N	Baseline	Follow-Up	Within-Group Change*	Between-Group Change†
		Mean ± Standard Deviation		*P*-Value	
Bathroom (6 items)					
Fall prevention	122	3.8 ± 1.3	3.5 ± 1.2	<.001	.02
Health education	124	3.5 ± 1.3	3.4 ± 1.3	.03	
Floor (11 items)					
Fall prevention	126	2.5 ± 1.5	2.4 ± 1.4	.72	.11
Health education	121	2.4 ± 1.4	2.8 ± 1.5	.02	
Lighting (8 items, including night lights)					
Fall prevention	116	3.4 ± 1.2	2.8 ± 1.4	<.001	<.001
Health education	114	3.1 ± 1.4	3.2 ± 1.2	.09	
Lighting (4 items, excluding night lights)					
Fall prevention	119	0.5 ± 0.7	0.4 ± 0.6	.30	.12
Health education	117	0.3 ± 0.6	0.3 ± 0.6	.36	
Storage (4 items)‡					
Fall prevention	71	1.7 ± 1.1	1.9 ± 1.1	.80	.16
Health education	64	1.8 ± 1.0	1.6 ± 1.0	.12	
Stairway (8 items)§					
Fall prevention	73	2.1 ± 1.2	2.2 ± 1.0	.21	.92
Health education	76	2.1 ± 1.1	2.2 ± 1.0	.48	
Total (29 items with night lights)‖‡					
Fall prevention	126	11.1 ± 2.6	9.9 ± 2.6	<.001	<.001
Health education	123	10.4 ± 2.6	10.6 ± 2.8	.68	
Total (25 items without night lights)‖‡					
Fall prevention	126	8.1 ± 2.3	7.5 ± 2.2	.01	.047
Health education	123	7.6 ± 2.1	7.7 ± 2.5	1.00	

Note: Numbers vary because of refusals to allow inspections in certain areas of the home, lack of storage areas in room, does not use tub or shower for bathing, no stairs in home, or missing item.

* Wilcoxon Signed Ranks test of change over time within a single group.

† Mann Whitney *U* test to compare amount of change between groups.

‡ Reflects only participants with storage areas in the kitchen, living room, bathroom, and bedroom.

§ Reflects only participants whose homes had stairways.

‖ Excluding stairway category and living room storage item from storage category, because approximately half of participants did not have or use these in their homes.

prevention program.[25] Another strength was the use of a population-based sample. Only one other study reported on population-based estimates of environmental hazards, and a high percentage of their population resided in age-restricted housing, presumably with better safety features.[34] The results in the current study provide evidence of the prevalence of environmental hazards in a population that resided predominantly in non-age-restricted housing. They also suggest how likely older women would be to follow home modification recommendations without financial or technical assistance.

It is difficult to compare the results of this study directly with results of others with respect to making home modifications because of the heterogeneity of measurement approaches and reporting. However, the overall rate of making recommended changes is consistent with some studies[24,25] and considerably less than in other studies in which safety devices were provided and installed at minimal or no cost to study participants.[8,13,16] The study outcomes suggest that, to be most effective, a home safety assessment and modification program must provide safety devices that can be immediately installed; otherwise, changes are unlikely to occur. The most common home modification made was installing night lights with which participants were provided. This finding is consistent with prior research that noted that participants are more likely to make simple, inexpensive modifications than those that are more complex or costly, such as adding hand rails or grab bars or repairing unsafe flooring.[8,13,25] There was limited adherence to making recommended home modifications, even with participants who set goals to implement home modifications and who had weekly contact with and encouragement from nurses over 2 months.

Although all homes had modifiable environmental hazards at baseline, a significant number of participants did not prioritize a goal to reduce these hazards. Several reasons might explain this. First, participants received a list of all their fall risk factors and may have selected to focus on goals unrelated to environmental hazards such as improving balance and muscle strength. Second, older women's

experiences with falls and injurious falls, their perceived susceptibility to falling, self-efficacy in preventing falls, beliefs about environmental hazards, personal meaning ascribed to aspects of the environment, their freedom in decision-making about the home environment (e.g., owning their residence), and the perceived and actual costs of home modifications influence their willingness to make home modifications.[25,35,36] From anecdotal information collected in this study as well as in other studies,[37] many older people disregarded the advice on making home modifications, because they did not feel it was personally relevant or needed. The challenge in developing future home safety programs for older adults will be to increase their awareness of personal susceptibility to falling to persuade them to make changes.

Consistent with prior studies,[11,12,33,34] the findings indicate that environmental hazards are highly prevalent in the homes of older adults. At baseline, each house had on average 10.7 modifiable hazards. Other studies have reported the presence of modifiable environmental hazards in 60.4% to 91.3% of homes studied,[17,33,34] with wide variation in average number of hazards per home. There is a need to develop consensus on home environmental assessment instruments that include standardized scoring schemes that can be used in future research on fall prevention and home modifications, because these instruments vary according to study, making comparisons difficult.

There were several important study limitations. The follow-up period was short, and it is possible that a greater number of home modifications might have been implemented had the follow-up period been longer so that participants had more time to correct hazards. The intervention nurses anecdotally reported that participants seemed initially reluctant to correct environmental hazards when presented with their comprehensive list of fall risk factors. They appeared more likely to make home modifications after their awareness increased through education, they had established rapport and a trusting relationship with the intervention nurse, and they had received repeated encouragement for making home modifications over several weeks. This is supported by the participants' high rate of not prioritizing goals to reduce environmental hazards and the finding that some of these participants had made home modifications by follow-up (6%, n = 6). However, the intervention intensity, which involved weekly contact for at least 8 weeks after the introduction of home modification recommendations, somewhat offset this limitation. Another limitation relates to this study being a secondary analysis of a trial testing the efficacy of a multifactorial fall prevention intervention. Thus, the study was not powered a priori to detect group differences in environmental hazards, although significant differences were noted between groups in several environmental hazard categories, including total hazards. Although these changes are statistically significant, they may not have clinical significance. Prior studies testing home modifications as a fall prevention strategy have been inconclusive.[9,13,23] Furthermore, there is no agreement on which hazards deserve the most attention for intervention, although slippery surfaces, stairs, and tripping hazards are implicated in injurious falls. Finally, the low recruitment rate (6.6%) from eligible women, with the study population being predominantly white, well educated, and with middle incomes, limits generalizability of the results.

The public health implications of falls in the older population have led to a national agenda for fall prevention to increase home safety awareness, education, and intervention programs.[38] Recent legislation introduced into the U.S. Congress (S. 1531, the Keeping Seniors Safe from Falls Act) would provide funding to support an education campaign and research focusing on reducing falls among older adults. Given the study outcomes, any education campaign should include information on home safety assessment and modification. However, future interventions should consider how to incorporate financial and practical assistance for making needed home modifications. Demonstration programs suggest that home safety interventions are well accepted by older adults and are likely to lead to having environmental hazards removed.[26,39,40]

The development of standardized assessment instruments and methods for reporting study outcomes on environmental hazards would enhance future research on home safety assessment and modifications programs. Research is needed on the facilitators that influence successful implementation of home modifications and how to best engage older adults in this process. Studies are also needed that can examine community-based approaches to increasing public awareness of falls and home safety and the need to reduce environmental hazards in older persons' homes. One approach might be to test a program that targets the children of older adults to see if this has a benefit in reducing fall hazards in their parents' homes, because they may be able to better assist in making home modifications. However, the older adult's autonomy would need to be considered in such an approach.

In conclusion, an intensive program of fall and home safety education and individualized counseling led to only modest reductions in environmental hazards in this population-based sample of older women who were at risk of falling. The provision of night lights influenced the results, which suggests that assisting older women in obtaining and installing devices might result in greater reductions of fall hazards in their homes. In future home modification programs, consideration should be given to increasing community awareness of home safety and the provision and installation of safety devices.

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were responsible for the study concept and design. Holly Hatch Stock conducted the majority of the data analyses. Catherine Croghan and Kristine Talley were intervention nurses and assisted in the data analyses. Melinda Monigold and Nancy M. Nachreiner participated in the acquisition of subjects and data.

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REFERENCES

1. Stevens JA. Gender differences for non-fatal unintentional fall related injuries among older adults. Inj Prev 2005;11:115–119.
2. Rubenstein LZ, Josephson KR. The epidemiology of falls and syncope. Clin Geriatr Med 2002;18:141–158.
3. Tinetti ME, Williams CS. Falls, injuries due to falls, and the risk of admission to a nursing home. N Engl J Med 1997;337:1279–1284.
4. Tinetti ME, Williams CS. The effect of falls and fall injuries on functioning in community-dwelling older persons. J Gerontol A Biol Sci Med Sci 1998; 53A:M112–M119.
5. Tinetti ME, Doucette JT, Claus EB. The contribution of predisposing and situational risk factors to serious fall injuries. J Am Geriatr Soc 1995;43: 1207–1213.
6. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. N Engl J Med 1988;319:1701–1707.
7. Lach HW, Reed AT, Arfken CL et al. Falls in the elderly: Reliability of a classification system. J Am Geriatr Soc 1991;39:197–202.
8. Stevens M, Holman CD, Bennett N. Preventing falls in older people: Impact of an intervention to reduce environmental hazards in the home. J Am Geriatr Soc 2001;49:1442–1447.
9. Stevens M, Holman CD, Bennett N et al. Preventing falls in older people: Outcome evaluation of a randomized controlled trial. J Am Geriatr Soc 2001;49:1448–1455.
10. Berg WP, Alessio HM, Mills EM et al. Circumstances and consequences of falls in independent community-dwelling older adults. Age Ageing 1997;26:261–268.
11. Northridge MR, Nevitt MC, Kelsey JL et al. Home hazards and falls in the elderly: The role of health and functional status. Am J Public Health 1995;85:509–515.
12. van Bemmel T, Vandenbroucke JP, Westendorp RG et al. In an observational study elderly patients had an increased risk of falling due to home hazards. J Clin Epidemiol 2005;58:63–67.
13. Cumming RG, Thomas M, Szonyi G et al. Home visits by an occupational therapist for assessment and modification of environmental hazards: A randomized trial of falls prevention. J Am Geriatr Soc 1999;47:1397–1402.
14. Steinberg M, Cartwright C, Peel N et al. A sustainable programme to prevent falls and near falls in community dwelling older people: Results of a randomised trial. J Epidemiol Community Health 2000;54:227–232.
15. Hogan DB, MacDonald FA, Betts J et al. A randomized controlled trial of a community-based consultation service to prevent falls. Can Med Assoc J 2001;165:537–543.
16. Day L, Fildes B, Gordon I et al. Randomised factorial trial of falls prevention among older people living in their own homes. BMJ 2002;325:128–131.
17. Nikolaus T, Bach M. Preventing falls in community-dwelling frail older people using a home intervention team (HIT): Results from the randomized Falls-HIT trial. J Am Geriatr Soc 2003;51:300–305.
18. Lyons RA, Sander LV, Weightman AL et al. Modification of the home environment for the reduction of injuries. Cochrane Database Syst Rev 2003;(4): CD003600.
19. Chang JT, Morton SC, Rubenstein LZ et al. Interventions for the prevention of falls in older adults: Systematic review and meta-analysis of randomized clinical trials. BMJ 2004;328:680–687.
20. Campbell AJ, Robertson MC, La Grow SJ et al. Randomised controlled trial of prevention of falls in people aged $\geq$75 with severe visual impairment: The VIP trial. BMJ 2005;331:817.
21. Gillespie LD, Gillespie WJ, Robertson MC et al. Interventions for preventing falls in elderly people. Cochrane Database Syst Rev 2003;4:CD000340.
22. McClure R, Turner C, Peel N et al. Population-based interventions for the prevention of fall-related injuries in older people. Cochrane Database Syst Rev 2005;1:CD004441.
23. Peel N, Steinberg M, Williams G. Home safety assessment in the prevention of falls in older people. Aust N Z J Public Health 2000;24:536–539.
24. Gerson LW, Camargo CA Jr, Wilber ST. Home modification to prevent falls by older ED patients. Am J Emerg Med 2005;23:295–298.
25. Ryan JW, Spellbring AM. Implementing strategies to decrease risk of falls in older women. J Gerontol Nurs 1996;22:25–31.
26. Thompson PG. Preventing falls in the elderly at home: A community-based program. Med J Aust 1996;164:530–532.
27. Lambert C, Sterbenz KA, Womack DE et al. Adherence to a fall prevention program among community dwelling older adults. Phys Occup Ther Geriatr 2001;18:27–43.
28. Wagner EH, LaCroix AZ, Grothaus L et al. Preventing disability and falls in older adults: A population-based randomized trial. Am J Public Health 1994;84:1800–1806.
29. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method of grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.
30. Rodriguez JG, Sattin RW, DeCito CA et al. Developing an environmental hazards assessment instrument for falls among the elderly. In: Weindruch R, Hadley EC, Ory MG, eds. Reducing Frailty and Falls in Older Adults. Springfield, IL: Charles C. Thomas Publisher, 1991, pp 263–276.
31. Rodriguez JG, Baughman AL, Sattin RW et al. A standardized instrument to assess hazards for falls in the home of older persons. Accid Anal Prev 1995;27:625–631.
32. Lachman ME, Howland J, Tennstedt S et al. Fear of falling and activity restriction. The survey of activities and fear of falling in the elderly (SAFE). J Gerontol B Psychol Sci Soc Sci 1998;53B:P43–P50.
33. Huang TT, Acton GJ. Effectiveness of home visit falls prevention strategy for Taiwanese community-dwelling elders: Randomized trial. Public Health Nurs 2004;21:247–256.
34. Gill TM, Williams CS, Robison JT et al. A population-based study of environmental hazards in the homes of older persons. Am J Public Health 1999;89:553–556.
35. Clemson L, Cusick A, Fozzard C. Managing risk and exerting control: Determining follow through with falls prevention. Disabil Rehabil 1999;21: 531–541.
36. Ohta RJ, Ohta BM. The elderly consumer's decision to accept or reject home adaptations: Issues and perspectives. In Lanspery S, Hyde J, eds. Staying Put: Adapting the Places Instead of the People. Amityville, NY: Baywood, 1997, pp 79–89.
37. Yardley L, Donovan-Hall M, Francis K et al. Older people's views of advice about falls prevention: A qualitative study. Health Educ Res 2006;21: 508–517.
38. Falls Free: Promoting a National Falls Prevention Action Plan 2005. National Council on Aging [on-line]. Available at http://www/ncoa.org Accessed April 14, 2006.
39. Plautz B, Beck DE, Selmar C et al. Modifying the environment: A community-based injury-reduction program for elderly residents. Am J Prev Med 1996; 12(Suppl 1):33–38.
40. Thompson PG. Preventing falls in the elderly at home: A community-based program. Med J Aust 1996;164:530–532.