# Home Hazards and Falls in the Elderly: The Role of Health and Functional Status


## ABSTRACT

*Objectives.* This study was undertaken to determine whether vigorous and frail older people who identify environmental hazards in their homes have an increased risk for falls.

*Methods.* A 1-year prospective study was conducted among 266 female and 59 male community-dwelling volunteers aged 60 to 93 years who had fallen at least once during the previous year. Composite measures of home safety and of frailty were derived using principal components analysis. Participants were divided into vigorous and frail groups, and associations between baseline home safety measures and falls at home over the follow-up year were compared between the two groups.

*Results.* Frail individuals were more than twice as likely as vigorous individuals to fall during follow-up (rate ratio [RR] = 2.24; 95% confidence interval [CI] = 1.54, 3.27). In the study group as a whole, falls were not strongly associated with the presence of home hazards. However, when compared with vigorous older persons living with fewer home hazards, vigorous older persons living with more home hazards were more likely to fall. The increased risk for falls among vigorous elderly was limited to falls where home hazards were present. By contrast, living with more home hazards was not associated with increased likelihood of falls among frail older persons.

*Conclusions.* While frail older persons experience higher overall fall rates, vigorous older persons should not be overlooked in fall prevention projects. (*Am J Public Health.* 1995;85: 509–515)



*Mary E. Northridge, PhD, MPH, MT, Michael C. Nevitt, PhD, Jennifer L. Kelsey, PhD, and Bruce Link, PhD*


## Introduction

Approximately one third of adults aged 65 years or older fall each year,[1–3] implicating environmental factors in one third to one half of their falls.[4,5] While the entire spectrum of elderly persons suffer falls and their sequelae, the relative contribution of intrinsic characteristics and the environment may differ according to the person's functional level.[6–9] In this paper we report the relationships between the presence of self-identified home hazards and fall risk in both vigorous and frail elderly persons.

## Methods

Persons aged 60 years or older who reported falling at least once in the previous 12 months were recruited from senior centers, senior residences, churches, and university-affiliated outpatient medical clinics in San Francisco, Calif. Those unable to walk without the assistance of another person, unable to answer the interview questions, or living in a nursing home were excluded. In all, 325 persons (266 women and 59 men) were enrolled in the study.

### *Baseline Assessments*

All eligible participants underwent a three-part baseline examination at the study center. This consisted of a questionnaire administered by a trained interviewer; a physical examination conducted by an internist; and tests of neuromuscular performance, visual function, and mental status carried out by trained lay examiners. In addition, all participants completed a take-home environmental checklist that assessed home features that potentially contributed to falls. Details of these instruments have been previously published[10,11]; summaries and descriptions of selected variables are provided here.

The standardized structured questionnaire included questions about demographic characteristics, falls over the past 12 months, and health and physical functioning. Functional status was measured by a respondent's answers to questions concerning his or her ability to perform six activities of daily living without assistance from another person or the use of special aids or equipment.

Following a standard interview by a trained lay examiner regarding each person's medical conditions and medication use, a board-certified internist performed a cardiovascular, neurological, and musculoskeletal physical examination. A written protocol based on standard techniques was used.[12]

Qualitative abnormalities of gait (e.g., stepping asymmetry and arrythmicity, weaving, staggering, shuffling, and reduced arm swing)[13] were noted while the participant walked 5 m at normal pace, and the number of abnormalities present


Mary E. Northridge and Bruce Link are with the Division of Epidemiology, Columbia University School of Public Health, New York, NY. Michael C. Nevitt is with the Department of Epidemiology and Biostatistics, University of California in San Francisco. Jennifer L. Kelsey is with the Division of Epidemiology, Stanford University School of Medicine, Stanford, Calif.

Requests for reprints should be sent to Mary E. Northridge, PhD, MPH, MT, Gertrude H. Sergievsky Center, Columbia University, 630 W 168th St, Box 16, New York, NY 10032.



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was recorded. Static balance was tested by measuring the time a person could stand on one leg. If the participant could not perform a given task, the lowest possible score was assigned.

Corrected visual acuity was measured by letter charts using a method described by Bailey and Lovie.[14] The Mini-Mental State Examination,[15] in which participants are asked basic orientation and recall questions, was used to assess mental status. Depression was measured by the Geriatric Depression Scale[16] (15-item version, adjusted for unanswered items so that the variable analyzed was the frequency of depressed responses per the number of questions answered).

Participants were given a take-home questionnaire that asked about features of their residence that might contribute to falls and about their safety behavior at home. The questionnaire guided the participants through their homes and instructed them to look for and record specific items, including the condition of the floors, the presence of tripping hazards, and the degree of lighting in the hallways and passageways; conditions that make it difficult or unsafe to use the kitchen (e.g., cabinets that are too high or too low); and the presence of grab bars and nonslip surfaces in the bathroom. A nurse practitioner used the same instrument to survey 72 participants' homes to obtain a measure of reliability.

### *Follow-Up Period*

For the purposes of this study, a fall was defined as "falling all the way to the floor or ground, or falling and hitting an object such as a chair or stair." This definition was explained to all participants and was printed on a postcard holder containing 52 dated and postage-paid postcards (one for each week of follow-up). Participants were instructed to report whether they had fallen in the previous week and to mail the card immediately. If a postcard was not received within 10 days of the designated mailing date, the participant was contacted by telephone.

As soon as possible after each reported fall, a nurse practitioner interviewed the participant at home. She reviewed the circumstances of the incident and determined whether the reported fall met the study definition of a fall.

### *Analysis*

*Outcome variables.* Falls that occurred because of loss of consciousness (syncope or seizure) or sudden paralysis were excluded. First and second falls at home during follow-up were initially examined separately as outcome events, but the number of second falls was too small for meaningful interpretation. Therefore, the sole endpoint presented in this paper is first nonsyncopal falls at home during follow-up. Rate ratios (RRs) for selected predictor variables (such as environmental hazards) were calculated using the Cox proportional hazards model available in the EGRET statistical package.[17,18] All multivariate Cox models were adjusted for age, sex, and race (White vs non-White).

Several questions from the postfall assessment were useful in determining whether there was an environmental contribution to the fall. This determination included whether the person reported (1) that a specific hazard caused the fall; (2) that he or she tripped or slipped over a particular item; or (3) that the fall occurred on stairs, steps, a curb, or another change of level. If the response was yes to any of these items, the fall was classified as environmental; all other falls were considered nonenvironmental.

*Environmental scales formation.* Principal components analysis[19] was used to examine intercorrelations between items on the home hazard checklist and to devise meaningful scales of home safety. Robust factor scores were computed by counting endorsements of items that had relatively large loadings on a given factor. The actual magnitude of the loading was not used in these calculations.[20] The SAS procedure PROC FACTOR, Methods = Principal[21] was used along with several variations.

Values beyond +0.5 or −0.5 were initially considered to make a meaningful contribution to the principal component; the variance explained and the plausibility of item groupings were also used to decide how many factors to retain. Home hazard scales were created by adding the scores on each of the component variables (either 0 or 1) in the environmental factors of interest. Higher scores translate into poorer safety design or a more hazardous condition in the home.

*Frailty scale formation.* Principal components analysis was again used. Baseline items from the structured interview, the physician's examination, and the tests of neuromuscular performance, vision, and mental status were used to help create an index of frailty in older persons. Items contained in the factors of interest (i.e., those with loadings beyond +0.5 or −0.5) were then scaled so that all the items were scored similarly ("0" for least disability, "1" for most disability).

Next, the scaled scores on each of the component items in the selected frailty factors were added together to create a composite measure of frailty. Higher scores translate into frailer participants.

*Associations between baseline home hazard scales and environmental (and nonenvironmental) falls during follow-up.* Polytomous logistic regression was used to determine whether the presence of home hazards at baseline predicted environmental (and nonenvironmental) falls during follow-up. All logistic regression models were fitted iteratively by maximum likelihood estimation with the SYSTAT LOGIT program.[22] From these models, odds ratios were obtained as estimates of risk ratios.

## *Results*

### *Descriptive Characteristics*

During follow-up, 91 (34.2%) of the women and 18 (30.5%) of the men experienced one or more nonsyncopal falls at home. Another 75 participants (23.1%) fell at least once, but only away from home. Six individuals died and three dropped out prior to completing all 52 weeks of follow-up. These nine individuals contributed person-years of experience to the Cox models up until the time they were censored.

In total, 252 nonsyncopal falls at home were reported during the study: 196 for women and 56 for men. Table 1 provides the age-specific fall rates obtained by dividing the total number of nonsyncopal falls at home in each age and sex group by the corresponding number of person-years of follow-up. (The number of non-Whites [n = 59] was too small to consider separately.) Little age gradient is apparent except for the oldest age groups ($\geq$80 years for women and $\geq$75 years for men).

When we stratified the falls according to the order in which they occurred, we found that first falls were more likely to have had an environmental component than later falls. The percentage of falls classified as environmental according to our definition was 46.8% for first falls, 44.6% for second falls, 34.6% for third falls, 35.3% for fourth falls, and 18.2% for fifth through twentieth falls during follow-up.

We also asked about the room in the residence where the fall occurred. First falls during follow-up took place in various settings (e.g., bedroom, 25%; kitchen,

**TABLE 1—Age-Specific Rates per Person-Year of Nonsyncopal Falls at Home for Women and Men over the Follow-Up Year**

| Age (y) at Baseline | Person-Years of Follow-Up | Nonsyncopal Falls at Home: No. | Nonsyncopal Falls at Home: Annual Fall Rate[a] |
|---|---|---|---|
| **Women** | | | |
| 60–64 | 46.2 | 29 | 0.63 |
| 65–69 | 55.0 | 38 | 0.69 |
| 70–74 | 65.7 | 37 | 0.56 |
| 75–79 | 46.0 | 27 | 0.59 |
| ≥80 | 52.0 | 65 | 1.25 |
| Total | 264.9 | 196 | 0.74 |
| **Men** | | | |
| 60–64 | 8.7 | 1 | 0.11 |
| 65–69 | 9.2 | 5 | 0.54 |
| 70–74 | 12.5 | 2 | 0.16 |
| 75–79 | 12.6 | 16 | 1.27 |
| ≥80 | 13.8 | 32 | 2.32 |
| Total | 56.8 | 56 | 0.99 |

[a]Rates were obtained by dividing the total number of falls over the follow-up year in each age and sex group by the corresponding number of person-years at risk.

**TABLE 2—Associations between Individual Items from the Baseline Home Hazard Checklist and First Nonsyncopal Falls during Follow-Up**

| Individual Environmental Survey Item[a] | % of Subjects Exposed[b] | First Falls: RR | First Falls: 95% CI[c] |
|---|---|---|---|
| Bathrooms | | | |
| No grab bar for toilet | 84.7 | 0.45 | 0.29, 0.70 |
| Loose or wobbly grab bars | 0.6 | 7.83 | 1.91, 32.1 |
| Bedroom | | | |
| Trouble getting in/out of bed | 12.1 | 2.26 | 1.40, 3.64 |
| Trouble due to "other"[d] | 10.2 | 2.46 | 1.50, 4.04 |
| Living/family room | | | |
| Difficulty with chairs/sofas | 27.5 | 2.51 | 1.70, 3.69 |
| Chairs/sofas too low | 12.9 | 2.04 | 1.28, 3.26 |
| Chairs/sofas too soft | 8.0 | 2.37 | 1.37, 4.09 |
| Difficulty due to "other"[e] | 12.6 | 2.00 | 1.24, 3.23 |
| Use of furniture for support | 15.9 | 2.13 | 1.38, 3.31 |

[a]Items from the environmental survey do not necessarily represent home hazards but were part of the self-administered home survey.
[b]Totals may vary owing to missing numbers.
[c]Rate ratios (RRs) and 95% confidence intervals (CIs) were estimated by the Cox proportional hazards model using first fall as the dependent variable.
[d]The most frequent responses were bad back, stiffness, arthritis, pain, and need support.
[e]The most frequent responses were bad back, arthritis, nonspecific difficulty, too weak, and stiffness.

8%; dining room, 22%) whereas later (i.e., fourth and subsequent) falls were largely confined to the bedroom.

### *Environmental Checklist Reliability*

Good to excellent agreement was found between the ratings of the nurse and the study participants for items from the environmental self-assessment having to do with structural hazards (e.g., $\kappa = 0.81$ for "no grab bar in bathtub"); less agreement was found for tripping and slipping hazards (e.g., $\kappa = 0.46$ for "can make hallway small rugs move by pushing with foot"). Agreement was poorer, as expected, for hazards that are easily moved or variable (e.g., $\kappa = 0.07$ for "obstacles on floor").

### *Individual Home Hazards*

Nine of 49 single items examined from the baseline environmental survey were significantly associated either positively or negatively with first nonsyncopal falls at home during follow-up (Table 2). While only two subjects (0.6%) reported having loose grab bars, those who did experienced markedly and significantly increased rates of falls compared with those who did not have such hazards. Items asked about and not found to be associated with nonsyncopal falls at home included the numbers of floors and rooms in the residence and the need to walk through dark areas at night before turning on a light.

### *Environmental Scales*

After examining the results of all principal components analyses, we selected the first eight factors for further inspection since these grouped items shared common themes and their rotated loadings were quite high (i.e., beyond −0.5 or +0.5). The Appendix provides an ordered listing of the environmental factors along with their constituent items. (Factor loadings are available upon request from the corresponding author; detailed analyses are provided elsewhere.[23])

Not all the factors composed of items from the environmental survey proved suitable for examining relations with falls or represented home hazards per se. For example, the underlying theme shared by all three items reported as "problems in transfer" (factor 5) may be intrinsic characteristics of the individuals rather than the design of the furniture. Consideration was also given to the proper form of the scale (dichotomized or ordinal) for use in subsequent analyses.

Next, relationships between environmental scales and falls were examined in the study group as a whole (Table 3). Clutter and small rug problems were associated with slightly increased fall frequency. Individuals who had trouble rising from a chair or bed or walking across a room without leaning on furniture for support experienced a significantly higher fall rate than older persons without such difficulties.

The absence of grab bars and nonskid rugs in the bathroom was somewhat unexpectedly associated with fewer falls during follow-up. A likely explanation (based on retrospective data collected at baseline) is that bathroom safety features are markers for multiple prior falls. Those individuals who expressed the "need" for grab bars in the bathroom experienced a slightly increased (although not statistically significant) fall frequency during follow-up. Storage problems were not associated with falls in the group as a whole.

### *Frailty Scale*

A priori categorizations of frailty based on participants' balance and gait scores or on other single measures were not as useful as a composite score incorporating items from several different instruments. Although many different variations were tried, results from principal components analysis were most interpretable when (1) items similar to those used in a previous report[8] were included; (2) the original (vs dichotomized) forms of

**TABLE 3—Associations between Each Unit Increase in Environmental Scales and First Nonsyncopal Fall during Follow-Up**

| Environmental Scale | Range[a] | First Falls | |
|---|---|---|---|
| | | Adjusted RR | 95% CI[b] |
| Ordinal scales | | | |
| Storage problems | 0–3 | 1.03 | 0.83, 1.29 |
| Clutter | 0–2 | 1.24 | 0.89, 1.71 |
| Hall rug problems | 0–2 | 1.31 | 1.02, 1.69 |
| Problems in transfer | 0–3 | 1.53 | 1.28, 1.82 |
| Lack of safety features in bathroom | 0–3 | 0.78 | 0.64, 0.96 |
| | Cutpoint | | |
| Dichotomized scales | | | |
| Small rug problems | 0 vs 1–4 | 1.42 | 0.92, 2.19 |
| Need grab bars in bathroom | 0 vs 1–2 | 1.32 | 0.86, 2.04 |

[a]Permitted values are whole integers between and including the listed ranges; each unit increase corresponds to an additional home hazard reported by the subject (see text for items included in each of the given scales).
[b]Adjusted rate ratios (RRs) and 95% confidence intervals (CIs) were estimated by the Cox proportional hazards model for each additional home hazard reported for ordinal variables and the presence of "any" hazard vs "none" for dichotomized variables, and controlled for age, sex, and race. The first fall during follow-up was the dependent variable.

**TABLE 4—Associations between Environmental Scales and First Nonsyncopal Falls at Home during Follow-Up, by Subjects' Frailty Status**

| Environmental Scale[a] | Vigorous Subjects (n = 215)[b] | | Frail Subjects (n = 108)[b] | |
|---|---|---|---|---|
| | RR | 95% CI[c] | RR | 95% CI[c] |
| Ordinal scales | | | | |
| Storage problems | 1.17 | 0.89, 1.54 | 0.83 | 0.56, 1.24 |
| Clutter | 1.23 | 0.78, 1.96 | 1.21 | 0.76, 1.93 |
| Hall rug problems | 1.50 | 1.07, 2.11 | 1.03 | 0.70, 1.52 |
| Problems in transfer | 1.48 | 1.14, 1.94 | 1.38 | 1.07, 1.77 |
| Lack of safety features in bathroom | 0.90 | 0.66, 1.22 | 0.72 | 0.53, 0.97 |
| Composite home hazard scale | 1.19 | 1.00, 1.41 | 1.02 | 0.83, 1.26 |
| Dichotomized scales | | | | |
| Small rug problems | 1.94 | 1.04, 3.60 | 0.95 | 0.52, 1.73 |
| Need grab bars in bathroom | 1.33 | 0.70, 2.52 | 1.04 | 0.56, 1.92 |

[a]Composite home hazard scale was composed of storage problems, clutter, and hall rug problems (see text for individual items included in each of the other scales).
[b]Totals may vary owing to missing data.
[c]Adjusted rate ratios (RRs) and 95% confidence intervals (CIs) were estimated by the Cox proportional hazards model for each additional home hazard reported for ordinal variables and the presence of "any" hazard vs "none" for dichotomized variables, and controlled for age, sex, and race. The first fall during follow-up was the dependent variable.

the items were used; (3) the demographic variables of age, sex, and race were eliminated from the analysis; (4) the number of factors was restricted to two; and (5) orthogonal rotation was used.

Five items met our criterion for inclusion in factor 1 ("neurologic and muscular impairment") by having loadings larger than +0.5 or −0.5: Mini-Mental State Examination score, balance test score, number of gait abnormalities, number of activities of daily living with which subject needed help, and low knee muscle tone). By contrast, only two variables were included in factor 2 ("gets out and about"): how often the participant went out of his or her house or apartment in good weather, and how often the participant left his or her neighborhood. (Factor loadings are available upon request from the corresponding author.)

Frailty scales were derived by adding each of the scaled scores on the items identified as important in factor 1 and factor 2, separately. Cox models were evaluated using the frailty scales derived from the five factor 1 items and the two factor 2 items (alone and in combination), the home hazard scales of interest, and interaction terms between the frailty and home hazard scales. Results showed that factor 1—"neurologic and muscular impairment"—was important in determining fall rates in the presence of environmental hazards, whereas factor 2—"gets out and about"—was not. Because factor 2 showed no interaction with environmental hazards, we focused attention on factor 1 when assessing frailty in further analyses.

Next, participants were divided into "vigorous" and "frail" groups based on their scores on the selected frailty scale. A cutoff point of 1.2 was selected using stratified analyses and probability plots[24] to look for homogeneous groups with respect to fall experience, giving us twice as many participants in the vigorous (n = 215) as in the frail group (n = 108). Two participants had missing values for items that made up this frailty scale. Using the dichotomous form of the frailty scale, frail participants were more than twice as likely as vigorous participants to experience one or more falls at home during follow-up (RR = 2.24; 95% confidence interval [CI] = 1.54, 3.27).

### *Assessment of Interaction*

The relationships between the created home hazard scales and falls during follow-up in both vigorous and frail participants are provided in Table 4. Results show that storage problems, clutter, hall rug problems, and small rug problems are associated with somewhat elevated fall rates in healthy, active individuals. Hence, we combined storage problems, clutter, and hall rug problems into a composite home hazard scale. (Since "small rug problems" is partially redundant with "hall rug problems" and represents a dichotomized scale, it was not included.) While higher scores on this scale were not strongly associated with an increased fall rate in the group as a whole (RR = 1.11; 95% CI = 0.98, 1.26 for each additional problem recorded), more home hazards were associated with an increased fall rate among vigorous participants. For example, a score of "4" on the composite scale (meaning that four home hazards included in this scale were reported) compared with a score of "0" (no hazards reported) yields a rate ratio of 2.01 (95% CI = 1.01, 3.98) among vigorous partici-

pants but of only 1.11 (95% CI = 0.48, 2.54) among frail participants.

The relationships between reported difficulties rising from chairs or beds or walking across a room without leaning on furniture for support and increased fall rates were significant among both vigorous and frail participants, although somewhat less so in the latter. In contrast, the presence of safety features in the bathroom was associated with an increased risk for falls only among frail individuals. Finally, needing grab bars in the bathroom was associated with a slightly higher (although not statistically significant) fall frequency in both vigorous and frail individuals.

When interactions were examined by including product terms with the home hazard of interest and the continuous frailty scale in the Cox proportional hazards model, findings were consistent with the stratified results in Table 4.

**TABLE 5—Associations between the Derived Environmental Scale from the Baseline Assessment and Nonenvironmental (No Home Hazard Involved) and Environmental (Any Home Hazard Involved) First Falls at Home during Follow-Up, by Subjects' Frailty Status**

| Composite Home Hazard Scale (Range of 0–7) | Vigorous Participants (n = 215) | | | | Frail Participants (n = 108) | | | |
|---|---|---|---|---|---|---|---|---|
| | Nonenvironmental First Falls (n = 25)[a] | | Environmental First Falls (n = 31)[a] | | Nonenvironmental First Falls (n = 33)[a] | | Environmental First Falls (n = 20)[a] | |
| | OR | 95% CI[b] | OR | 95% CI[b] | OR | 95% CI[b] | OR | 95% CI[b] |
| One-unit increase | 1.10 | 0.82, 1.47 | 1.32 | 1.04, 1.68 | 0.98 | 0.68, 1.40 | 1.17 | 0.79, 1.73 |
| Four-unit increase | 1.45 | 0.45, 4.70 | 3.03 | 1.16, 7.88 | 0.92 | 0.22, 3.78 | 1.87 | 0.39, 8.88 |

[a]Totals may vary owing to missing data.
[b]Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated by multinomial logistic regression. The dependent variable was one or more falls during follow-up.
[c]Composite home hazard scale was composed of storage problems, clutter, and hall rug problems (see "Methods" for individual items included).

### *Associations between Baseline Home Hazard Scales and Environmental (and Nonenvironmental) Falls during Follow-Up*

Finally, we examined relationships in vigorous and frail participants between the baseline environmental scales and falls with an environmental component (environmental falls) and, for the sake of completeness, falls without an environmental component (nonenvironmental falls) that occurred during follow-up in order to determine whether the presence of environmental hazards predicted environmental falls per se. Vigorous participants living with more home hazards (as assessed by the composite home hazard scale) were more likely than those living with fewer home hazards to experience environmental falls during follow-up (Table 5). Among frail participants, however, the effect of living with more home hazards was small.

## *Discussion*

The results from this research provide evidence that (1) frail older persons experience more falls overall than do vigorous older persons, and (2) the presence of certain home hazards (e.g., storage problems, clutter, and hall rug problems) is more important in predicting falls at home among vigorous than among frail older persons.

This research has several strengths. The study was prospective and had nearly complete follow-up.[25] A multifaceted baseline assessment provided self-report, physician examination, and performance-based data with which to score the health and functioning of the study participants. Analytic techniques to devise scales of home safety and of frailty were constructed to provide more power. Finally, two measures of home safety were available: the environmental survey and the postfall assessment.

On the other hand, certain limitations of this study should be noted. The nature of the environmental survey made it necessary for us to make assumptions regarding an individual's exposure to several hazards. For instance, participants too weak to prepare their own meals would probably not report poor lighting over work areas in the kitchen, nor would they expose themselves to the potential risks involved in preparing meals, such as climbing on chairs to get to items that are out of reach. For purposes of these analyses, it would have been better to determine if participants were in fact exposed to certain items before we asked them about hazardous conditions.

Furthermore, our assessment of whether a fall was environmental based on the participant's responses to the postfall assessment also had shortcomings. Noting that a hazard was involved does not allow assessment of how this effect is modified by functional abilities or of whether potential hazards interact to cause falls.[26] While other approaches to classifying falls have also relied largely on self-report,[27,28] this information is not likely to be completely accurate and may be affected by the seriousness of the fall.[25] Other limitations of this study include the lack of generalizability to all older persons (especially those living in nursing homes or with cognitive impairment[29,30]), the lack of repeated measures on baseline items that may have changed over the course of the study, and the relatively small sample size.

Previous investigators have examined relationships between environmental hazards and falls in older persons according to functional ability. Lipsitz et al. prospectively followed ambulatory frail nursing home residents and found that environmental hazards were rarely implicated as primary causes of falls (only 4 of 70 recurrent fallers stated that environmental hazards contributed directly to their index fall).[28] Speechley and Tinetti were able to separate elderly participants into different functional groups (frail, transitional, and vigorous) and examine the frequency and circumstances of falls within each.[8] While not statistically significant, their trends indicate a greater role of environmental factors in falls among vigorous participants. The present findings confirm and extend this research by suggesting that vigorous participants living with home hazards are specifically at increased risk for falls involving home hazards but are not at increased risk for falls where no home hazard is involved. The utility of environmental modifications to reduce fall rates in this active group of older persons should therefore be investigated.

Since falls tend to occur where people spend the most time, home-oriented prevention strategies may be most effective in reducing fall rates in older persons.[5,6] Education and awareness should accompany efforts to make

the home environment safer.[31,32] Especially critical are studies that examine home-based behaviors and activities that predispose to falls. It is also of interest to know whether home hazards contribute to injuries from falls.

Frail older persons are especially vulnerable to injury because of repeated falls and compromised function; thus, every effort should be made to determine the circumstances and conditions under which they fall.[30,31] However, active older persons should not be ignored in fall prevention programs. Trials of environmental interventions to reduce the risk of falls at home should focus on less frail elderly. Preventive strategies to reduce falls in older persons may be more effectively designed and targeted if consideration is given to living environments and the ability of individuals to function in their homes. □

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*Continued*

**APPENDIX—The First Eight Factors Derived from Principal Components Analysis Using Responses from the Baseline Environmental Survey and Their Constituent Items[a]**

Factor 1 ("Storage problems")
- "Cabinets too high"
- "Cabinets too low"
- "Not enough storage space in kitchen"

Factor 2 ("Clutter")
- "Objects stored on floor, even temporarily"
- "Have to turn to avoid furniture or objects"

Factor 3 ("Small rug problems")
- "Some small rugs in hallways not secured to floor"
- "Can make hallway small rugs move by pushing with foot"
- "Small rugs in bathroom not slip resistant"
- "Can make bathroom small rugs move by pushing with foot"

Factor 4 ("Poor lighting")
- "Not enough light over work areas in kitchen"
- "Not enough light in bathroom"
- "Not enough light in bedroom"

Factor 5 ("Problems in transfer")
- "Trouble getting in/out of bed"
- "Difficulty getting in/out of chairs/sofas"
- "Use furniture to support self when walking across room"

Factor 6 ("Lack of safety features in bathroom")
- "Lack of nonslippery surfaces in bathtub"
- "No grab bar in bathtub"
- "No grab bar for toilet"

Factor 7 ("Climbing aids")
- "Stand on a chair when things are out of reach"
- "Have a step stool which is stable and in good repair"

Factor 8 ("Need grab bars in bathroom")
- "Bath or shower needs grab bars"
- "Toilet needs grab bars"

[a]That is, those with rotated loadings greater than +0.5 or less than −0.5.