FALLS, INJURIES DUE TO FALLS, AND THE RISK OF ADMISSION TO A NURSING HOME

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ABSTRACT

Background Falls warrant investigation as a risk factor for nursing home admission because falls are common and are associated with functional disability and because they may be preventable.

Methods We conducted a prospective study of a probability sample of 1103 people over 71 years of age who were living in the community. Data on demographic and medical characteristics, use of health care, and cognitive, functional, psychological, and social functioning were obtained at base line and one year later during assessments in the participants' homes. The primary outcome studied was the number of days from the initial assessment to a first long-term admission to a skilled-nursing facility during three years of follow-up. Patients were assigned to four categories during follow-up: those who had no falls, those who had one fall without serious injury, those who had two or more falls without serious injury, and those who had at least one fall causing serious injury.

Results A total of 133 participants (12.1 percent) had long-term admissions to nursing homes. In an unadjusted model, the risk of admission increased progressively, as compared with that for the patients with no falls, for those with a single noninjurious fall (relative risk, 4.9; 95 percent confidence interval, 3.2 to 7.5), those with multiple noninjurious falls (relative risk, 8.5; 95 percent confidence interval, 3.4 to 21.2), and those with at least one fall causing serious injury (relative risk, 19.9; 95 percent confidence interval, 12.2 to 32.6). Adjustment for other risk factors lowered these ratios to 3.1 (95 percent confidence interval, 1.9 to 4.9) for one noninjurious fall, 5.5 (95 percent confidence interval, 2.1 to 14.2) for two or more noninjurious falls, and 10.2 (95 percent confidence interval, 5.8 to 17.9) for at least one fall causing serious injury, but the association between falls and admission to a nursing home remained strong and significant. The population attributable risk of long-term admission to a nursing home for these three groups (the proportion of admissions directly attributable to the three categories of falls) was 13 percent, 3 percent, and 10 percent, respectively.

Conclusions Among older people living in the community falls are a strong predictor of placement in a skilled-nursing facility; interventions that prevent falls and their sequelae may therefore delay or reduce the frequency of nursing home admissions. (N Engl J Med 1997;337:1279-84.)

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curred before the base-line interview — up to four years before placement in a skilled-nursing facility — were considered in this study, however, and there was no differentiation between injurious and noninjurious falls.26 We undertook the present study to determine whether, and to what extent, falls and injuries due to falls are independently associated with the risk of admission to a skilled-nursing facility.

METHODS

Participants

The participants represented a probability sample of residents of New Haven, Connecticut, who were at least 72 years of age and living in the community. To recruit participants, we conducted a census of all 2483 age-restricted housing units in the city (i.e., those designed for older persons), as described previously.19,27 In addition, every 62nd non–age-restricted housing unit, identified through utility listings, was sampled, along with the next 12 addresses, to be screened for the possible inclusion of residents in the study. Of the 1436 persons 72 years of age or older who were identified in these households during the base-line interviews, conducted from October 1989 through August 1990, only 44 (3 percent) were deemed ineligible because they did not speak English, Spanish, or Italian; could not follow simple commands; or were not ambulatory within their own households. Among the 1392 eligible participants, 1103 (79 percent) agreed to be enrolled.

Base-Line Data Collection

Base-line interviews and assessments were completed in participants’ homes by trained nurses, who obtained information on each participant’s age, sex, race, marital status, living situation, type of housing (public age-restricted, private age-restricted, or non–age-restricted), previous admissions to nursing homes, and history of falls and injuries due to falls. Chronic conditions were identified from the participants’ statements about whether a doctor had ever told them that they had a myocardial infarction, stroke, cancer, diabetes mellitus, arthritis, or Parkinson’s disease, and whether they had ever had a hip fracture, other fracture since they reached 50 years of age, or amputation.

The Folstein Mini–Mental State Examination, the depression scale of the Center for Epidemiologic Study (CES-D), and the perceived amount of instrumental and emotional support received. The health-related and functional variables included age, sex, race, education level, living arrangements, and type of housing. The psychosocial–cognitive variables included the scores on the CES-D, the Folstein Mini–Mental State Examination, and the perceived amount of instrumental and emotional support received. The health-related and functional variables included the number of chronic conditions, body-mass index, degree of visual impairment, degree of hearing deficit, number of hospitalizations for reasons other than injury during the follow-up period (based on continuous review of discharges from the two local acute care hospitals), history of previous nurs-
Bivariate relationships between each of the base-line covariates and admission to a skilled-nursing facility were assessed with use of the chi-square test for categorical variables and t-tests for continuous variables. To test the crude association between the participant's status with regard to falls and admission to a skilled-nursing facility, we classified each participant according to the most serious category that he or she had been in at any time before admission to a skilled-nursing facility (or the end of study follow-up or death, for those without a stay in a skilled-nursing facility).

We examined the overall distribution of each continuous variable and the pattern of its association with both status with respect to falls and placement in a nursing home in order to determine whether there was an obvious threshold value or whether the variable should be treated continuously. We also considered accepted clinical cutoffs for a given variable (e.g., a score ≥16 on the CES-D). We then constructed proportional-hazards models including only fall status and a single covariate, in order to test which type of measurement of the covariate had the greatest effect on the regression coefficients for fall status. For all continuous variables, we also tested for higher-order effects by examining a model that included both a linear and a quadratic term. The quadratic term was maintained if the P value for its association with fall status was less than 0.1 or if it produced a marked reduction in the coefficients for fall status as compared with the linear term alone. For variables with a substantial amount of missing data (>5 percent), we categorized the variable so as to adjust as well as possible for confounding and then included “missing” as an additional category. The score on the CES-D, the State–Trait Anxiety Inventory, and body-mass index were treated in this way. The categories for body-mass index were established separately for men and women.

Multivariate analysis was carried out with use of proportional-hazards regression with time-dependent covariates. The outcome was the number of days from the base-line interview to the first admission to a skilled-nursing facility that met our criteria; data on participants without an admission were censored at the time of death or at the end of study follow-up, as appropriate. In constructing the time-dependent covariates for fall status, we assumed that the effect of a fall would last three months; thus, when a fall occurred, the participant was counted in the appropriate category with respect to falls from the date of the fall until three months later. At that point, unless another fall had occurred, the participant was recategorized as having no falls until another fall occurred or until the end of follow-up. The number of hospitalizations for reasons other than injury was also updated continuously, according to the dates of hospital admission; thus, this time-dependent covariate represented the cumulative total of non–injury-related hospitalizations. The other covariates, which were assessed at base line and at the one-year follow-up interview, were updated at the time of the one-year interview. If participants had missing data at the one-year follow-up interview, base-line values of the covariates were maintained. Because there is no software currently available to compute weighted proportional hazards with time-dependent covariates, we instead added dummy variables for the type of housing to account for the stratified sampling design.

A series of hierarchical proportional-hazards models was constructed, in which each category of covariates was successively added. The first model included only the dummy variables for fall status, and the final model included all three groups of covariates. The population attributable risk of placement in a nursing home associated with fall status (i.e., the proportion of the admissions that were directly attributable to each category of fall) was calculated from this final model according to the following formula: \( (100 \times \text{prevalence} \times (\text{hazard ratio} - 1)) / ((\text{prevalence} \times (\text{hazard ratio} - 1) + 1)) \). Prevalence was calculated as the number of person-years of observation with the risk factor, divided by the total number of person-years of observation. The final model was repeated with participants assigned to their most serious category with respect to falls throughout the remainder of follow-up, rather than reverting to the “no-falls” category after three months.

**RESULTS**

**Nursing Home Admissions**

Of the 1103 members of the cohort, 165 (15.0 percent) had at least one stay in a skilled-nursing facility during follow-up. Twenty-nine participants had stays that were covered completely by Medicare, and three had stays of less than two weeks. Thus, a total of 133 participants (12.1 percent) had stays in skilled-nursing facilities that met our criteria for long-term care. Of these 133, 12 had an earlier nursing home stay that was entirely covered by Medicare. The median time from base line to admission was 601 days (range, 10 to 1151). Forty-seven participants remained in a skilled-nursing facility at the end of follow-up. For the remaining 86 participants, who either died in the nursing home (12 patients) or were discharged (74), the median length of stay was 135 days.

**Bivariate Analyses**

As shown in Table 1, several characteristics were associated with admission to a skilled-nursing facility in bivariate analyses. Many of these characteristics were also associated with the participants’ status with respect to falls. When the data were analyzed according to participants’ most serious fall status before admission to a skilled-nursing facility or censoring of data, fall status was significantly associated with nursing home placement (P<0.001). The bivariate relation between the category with respect to falls and the risk of admission to a skilled-nursing facility during each of the three years of follow-up was similar to that shown in Table 1 for the entire follow-up period.

Among the 137 participants with a serious injury due to a fall during follow-up, 95 had fractures (33 of the hip, 7 of the pelvis, 13 of other sites in the leg or foot, 7 of the humerus, 15 of other sites in the arm or hand, 17 of ribs or vertebrae, 2 of facial bones, and 1 of unknown type); 12 had serious joint injuries; 2 had intracranial injuries; and 28 had other serious injuries necessitating medical care and a reduction in activity.

Table 2 shows the results of the series of proportional-hazards models. In the unadjusted model, even a single, noninjurious fall was associated with an elevated risk of placement in a nursing home. Participants with multiple noninjurious falls had a higher risk than those with a single fall, whereas those with one or more falls that caused serious injury were at the highest risk of placement in a skilled-nursing facility. The sequential adjustment for the covariates lowered the hazard ratios associated with falling, but for each category of status with respect to falls the relation remained statistically significant. The population attributable risk of placement in a skilled-nurs-
**Table 1.** Baseline characteristics and status with respect to falls of 1103 participants with and without a stay in a skilled-nursing facility.*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Stay in Skilled-Nursing Facility</th>
<th>P Value</th>
<th>Characteristic</th>
<th>Stay in Skilled-Nursing Facility</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES (N = 1123)</td>
<td>NO (N = 970)</td>
<td></td>
<td>YES (N = 1123)</td>
<td>NO (N = 970)</td>
</tr>
<tr>
<td>Age (yr)†</td>
<td>83.3±5.8</td>
<td>79.1±5.0</td>
<td>&lt;0.001</td>
<td>Emotional social support‡‡</td>
<td>0.088</td>
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<tr>
<td>Female sex (%)</td>
<td>75.2</td>
<td>72.6</td>
<td>0.525</td>
<td>Not needed</td>
<td></td>
</tr>
<tr>
<td>White race (%)</td>
<td>89.5</td>
<td>83.2</td>
<td>0.064</td>
<td>Available</td>
<td></td>
</tr>
<tr>
<td>Education (yr)</td>
<td>9.3±3.5</td>
<td>9.6±3.6</td>
<td>0.354</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td>Type of housing (%)</td>
<td></td>
<td></td>
<td></td>
<td>Body-mass index (%)‡‡</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Private, age-restricted</td>
<td>69.9</td>
<td>55.2</td>
<td>0.003</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Public, age-restricted</td>
<td>9.8</td>
<td>10.6</td>
<td></td>
<td>Intermediate</td>
<td></td>
</tr>
<tr>
<td>Non-age-restricted</td>
<td>20.3</td>
<td>34.2</td>
<td></td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Living situation (%)</td>
<td></td>
<td></td>
<td></td>
<td>Missing</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>17.3</td>
<td>24.0</td>
<td>0.071</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living with others</td>
<td>6.0</td>
<td>9.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living alone</td>
<td>76.7</td>
<td>66.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of chronic conditions‡‡</td>
<td>1.3±1.0</td>
<td>1.4±1.1</td>
<td>0.746</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of medications†</td>
<td>4.1±2.6</td>
<td>3.7±2.7</td>
<td>0.156</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score on Folstein MMSE &lt;20 (%)†‡‡</td>
<td>30.2</td>
<td>10.3</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score on CES-D scale (%)†‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;16</td>
<td>26.3</td>
<td>19.0</td>
<td>&lt;0.001</td>
<td>Falls Efficacy score ‡‡‡</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>0–15</td>
<td>50.4</td>
<td>68.9</td>
<td></td>
<td>73.2±27.7</td>
<td>86±19.6</td>
</tr>
<tr>
<td>Missing</td>
<td>23.3</td>
<td>12.2</td>
<td></td>
<td>28.6</td>
<td>10.8</td>
</tr>
<tr>
<td>Spielberger State–Trait Anxiety Inventory (%)†‡</td>
<td>48.9</td>
<td>42.6</td>
<td>0.002</td>
<td>Any disability in ADL (%)††</td>
<td>1.2</td>
</tr>
<tr>
<td>≥32</td>
<td>32.3</td>
<td>46.7</td>
<td></td>
<td>1.8±1.4</td>
<td>1.1±1.2</td>
</tr>
<tr>
<td>Missing</td>
<td>18.8</td>
<td>10.7</td>
<td></td>
<td>No. of non-injury-related</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Instrumental social support‡</td>
<td></td>
<td></td>
<td></td>
<td>hospitalizations (%)‡‡‡</td>
<td></td>
</tr>
<tr>
<td>Not needed</td>
<td>8.0</td>
<td>18.0</td>
<td>0.008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available</td>
<td>80.8</td>
<td>75.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not available</td>
<td>11.2</td>
<td>6.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Status with respect to falls§§</td>
<td></td>
<td></td>
<td></td>
<td>Falls</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>No falls</td>
<td>24.8</td>
<td>50.6</td>
<td></td>
<td>44.4</td>
<td>67.2</td>
</tr>
<tr>
<td>1 Fall without serious injury</td>
<td>23.3</td>
<td>22.3</td>
<td></td>
<td>27.8</td>
<td>19.0</td>
</tr>
<tr>
<td>≥2 Falls without serious injury</td>
<td>22.6</td>
<td>17.0</td>
<td></td>
<td>27.8</td>
<td>13.8</td>
</tr>
<tr>
<td>≥1 Fall with serious injury</td>
<td>29.3</td>
<td>10.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Plus–minus values are means ±SD. P values are from chi-square tests in the case of categorical variables and t-tests in the case of continuous variables. The characteristics are presented in the form used in the models. A “missing” category is shown if one was included in the models (see the Methods section).

†This characteristic was significantly associated with status with respect to falls (P < 0.05 by the chi-square test for categorical variables, and by analyses of variance for continuous variables). MMSE denotes Mini–Mental State Examination, and ADL activities of daily living.

‡See the Methods section for definitions.

§Scores on the Folstein Mini–Mental State Examination** range from 0 to 30, with higher scores indicating better cognitive status.

||Scores on the Center for Epidemiologic Study — Depression scale** (CES-D) range from 0 to 60, with higher scores indicating more depressive symptoms.

‡‡In this tabulation, participants were assigned to the highest (worst) category for which they met the criteria during follow-up.

§§In this tabulation, participants were assigned to the highest (worst) category for which they met the criteria during follow-up.

**On this battery of tests, higher summary scores indicate faster performance of tasks.

††On this scale, higher scores indicate greater confidence.

‡‡Non–injury-related hospitalizations were defined as admissions for reasons other than the treatment of fall-related injuries at any time from the baseline interview until admission to a skilled-nursing facility, death, or the end of follow-up.

Table 1. Baseline characteristics and status with respect to falls of 1103 participants with and without a stay in a skilled-nursing facility.

The cumulative attributable risk for the three categories of falls was thus 26 percent. The adjusted relative risks from the final model, in which participants maintained their worst fall status from the time of the fall until the end of follow-up, were 3.1 (95 percent confidence interval, 1.7 to 5.4) for one noninjurious fall, 5.0 (95 percent confidence interval, 2.7 to 9.2) for two or more noninjurious falls,
and 11.6 (95 percent confidence interval, 6.6 to 20.5) for one or more falls causing serious injury. The attributable risks were 25 percent, 27 percent, and 38 percent, respectively.

DISCUSSION

In this prospective study of a representative cohort of older persons living in the community, we found an independent relation between falls and long-term placement in a skilled-nursing facility. The relation between falls and nursing home admission remained strong even after sequential adjustments for the other factors known to be associated either with falls or with placement in a skilled-nursing facility.

From this observational study, we cannot establish a direct cause-and-effect relation between falls and placement in a skilled-nursing facility. Our methods and analyses were designed, however, to assess the evidence of an association in an unbiased manner. First, both falls and admissions were ascertained prospectively. Short stays in a skilled-nursing facility and stays that might have occurred only for rehabilitation after a fall were excluded from the analysis. The matching between the cohort and the long-term care registry data sets was performed with use of a carefully designed and validated algorithm by personnel unaware of the status of participants with respect to falls. Second, the fact that in each case the fall preceded admission to a nursing home was ensured by prospective and continuous monitoring of both risk factors and outcomes. Third, we ensured a close temporal relation between falls and admissions by limiting the duration of a particular status with respect to falls to the three months after the event. Fourth, we adjusted for a large number of potential confounders through our hierarchical, multivariate models. In order to provide a conservative estimate of the risk associated with falls, we selected the measurement strategy for each confounder (continuous or categorical with the cutoff set at the best threshold) that most strongly affected the coefficients for fall status. As expected, because the covariates were known to be associated both with falling and with placement in a skilled-nursing facility, the strength of the relation was lessened somewhat by these adjustments. It is possible that additional unmeasured factors confounded the relation between status with respect to falls and placement in a skilled-nursing facility even though we adjusted for data on a wealth of physical, psychological, cognitive, and social factors measured at base line and during follow-up.
The mechanisms by which falls and injuries due to falls lead to placement in a skilled-nursing facility are plausible and readily apparent. Falls have been shown to result in a decline in function as a result both of physical injury and of a loss of confidence with regard to the ability to perform functional activities.\(^7\) Indeed, the reduction in the hazard ratios for each category of status with respect to falls when physical performance and functional disability were added to the model suggests that decline in function might partially, albeit not totally, explain the increased risk of placement in a skilled-nursing facility among elderly people who fall. Furthermore, the inability to get up after a fall, reported by up to half of people who fall, was previously found to be associated with placement in a skilled-nursing facility.\(^7\) Although we cannot exclude the possibility that falling is merely a marker for frailty in persons already at risk of institutionalization, another plausible interpretation of our findings is that falls, particularly frequent and injurious falls, contribute, along with physical, psychological, functional, and social factors, to the decision by older persons and their families to pursue placement in a skilled-nursing facility. Falls may precipitate admission to a nursing home among older persons with cognitive, physical, and social risk factors. Indeed, patients and their families often tell their health care providers that this has occurred.

Given the loss of autonomy and privacy and the financial costs associated with institutionalization, the identification of potentially preventable or modifiable risk factors should be a high priority. In randomized, controlled intervention trials, the rate of falling has been reduced by up to 40 percent among older persons living in the community.\(^20,23\) The preventive strategies tested in these trials, including adjustments in medications, exercise regimens, and behavioral recommendations, are feasible and relatively cost effective, and they could readily be incorporated into the care of older persons living in the community. The evidence suggests that preventing falls and their sequelae may delay or reduce admissions to nursing homes.

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REFERENCES