Falling is a common and highly morbid condition. Each year, about 30% of community-living persons aged 65 years or older will fall, and the incidence increases to about 50% among those aged 80 years or older.1-3 Approximately 10% of these falls will result in a serious injury, such as a fracture or traumatic brain injury.3-6 Falls account for approximately 10% of visits to an emergency department and 6% of hospitalizations among Medicare beneficiaries.7

Falls, particularly those resulting in injury, are independently associated with a decline in important functional activities, such as bathing and shopping, and with an increased risk of a long-term nursing home admission.8-9 Moreover, a recent study10 found that older persons who were hospitalized for an injurious fall had worse functional outcomes and a higher likelihood of a long-term nursing home admission than their counterparts who were hospitalized for a non-fall-related reason. The adverse consequences of these serious fall injuries, relative to those of the other disabling conditions, were observed not only for hip fracture but also for other fall-related injuries.10

In contrast to the accumulating body of knowledge about the natural history of serious fall injuries, particularly hip fractures,11-13 little is known about the course of disability (ie, functional trajectories) before a serious fall injury or the relationship between these trajectories and those that follow the fall. This information would provide physicians and policymakers with a more complete understanding of the functional antecedents and consequences of serious fall injuries, one of the most dreaded and devastating conditions experienced by older persons.14

IMPACT importance Although a serious fall injury is often a devastating event, little is known about the course of disability (ie, functional trajectories) before a serious fall injury or the relationship between these trajectories and those that follow the fall.

OBJECTIVES To identify distinct sets of functional trajectories in the year immediately before and after a serious fall injury, to evaluate the relationship between the prefall and postfall trajectories, and to determine whether these results differed based on the type of injury.

DESIGN, SETTING, AND PARTICIPANTS Prospective cohort study conducted in greater New Haven, Connecticut, from March 16, 1998, to June 30, 2012, in 754 community-living persons aged 70 years or older who were initially nondisabled in their basic activities of daily living. Of the 130 participants who subsequently sustained a serious fall injury, 62 had a hip fracture and 68 had another fall-related injury leading to hospitalization.

MAIN OUTCOMES AND MEASURES Functional trajectories, based on 13 basic, instrumental, and mobility activities assessed during monthly interviews, were identified in the year before and the year after the serious fall injury.

RESULTS Before the fall, 5 distinct trajectories were identified: no disability in 16 participants (12.3%), mild disability in 34 (26.2%), moderate disability in 34 (26.2%), progressive disability in 23 (17.7%), and severe disability in 23 (17.7%). After the fall, 4 distinct trajectories were identified: rapid recovery in 12 participants (9.2%), gradual recovery in 35 (26.9%), little recovery in 26 (20.0%), and no recovery in 57 (43.8%). For both hip fractures and other serious fall injuries, the probabilities of the postfall trajectories were greatly influenced by the prefall trajectories, such that rapid recovery was observed only among persons who had no disability or mild disability, and a substantive recovery, defined as rapid or gradual, was highly unlikely among those who had progressive or severe disability. The postfall trajectories were consistently worse for hip fractures than for the other serious injuries.

CONCLUSIONS AND RELEVANCE The functional trajectories before and after a serious fall injury are quite varied but highly interconnected, suggesting that the likelihood of recovery is greatly constrained by the prefall trajectory.
The objectives of the current study were to identify distinct sets of functional trajectories in the year immediately before and after a serious fall injury, to evaluate the relationship between the prefall and postfall trajectories, and to determine whether these results differed based on the type of injury, namely, hip fracture vs other serious fall injuries.

Methods

Study Population
Participants were drawn from an ongoing longitudinal study of 754 community-living persons aged 70 years or older, who were initially nondisabled in their basic activities of daily living. Potential participants were members of a large health plan. They were excluded if they had significant cognitive impairment with no available proxy, had a life expectancy less than 12 months, planned to move out of the area, or were unable to speak English. Based on our initial sample size calculations, persons who were physically frail were oversampled. Only 4.6% of persons refused screening, and 75.2% of those eligible agreed to participate and were enrolled from March 23, 1998, to October 26, 1999. Persons who refused to participate did not differ significantly from those who were enrolled in terms of age or sex. The study was approved by the Yale Human Investigation Committee, and all participants provided informed consent.

Data Collection
Comprehensive home-based assessments were completed at baseline and subsequently at 18-month intervals for 144 months (except at 126 months), and telephone interviews were completed monthly through June 30, 2012. For participants who had significant cognitive impairment or were otherwise unavailable, a proxy was interviewed according to a rigorous protocol, with demonstrated reliability and validity. Deaths were ascertained from the local obituaries and/or an informant during a subsequent interview; 550 participants (72.9%) died after a median of 86 months, and 40 (5.3%) dropped out of the study after a median of 27 months. Data were otherwise available for 99.2% of the 77,346 monthly interviews. During the comprehensive assessments, data were collected on demographic characteristics, 9 self-reported physician-diagnosed chronic conditions, cognitive status, depressive symptoms, and physical frailty, defined on the basis of slow gait speed.

Assessment of Disability
Complete details regarding the assessment of disability are provided elsewhere. During the monthly interviews, participants were asked, “At the present time, do you need help from another person to (complete the task)?” for each of 4 basic activities (bathing, dressing, walking, and transferring), 5 instrumental activities (shopping, housework, meal preparation, taking medications, and managing finances), and 3 mobility activities (walk a quarter mile, climb a flight of stairs, and lift or carry 10 lb). For these 12 activities, disability was operationalized as the need for personal assistance or inability to do the task. Participants were also asked, “Have you driven a car during the past month?” Those who responded no were considered to be “disabled” in driving. To address the small amount of missing data on disability, multiple imputation was used, with 100 random draws per missing observation.

Ascertainment of Serious Fall Injuries
Serious fall injuries included hip fractures and other fall-related injuries leading to hospitalization. Information on hospitalizations was obtained during the monthly interviews. The accuracy of these reports was high based on an independent review of hospital records. Injuries included fractures, head trauma, soft-tissue injuries, lacerations, and other fall-related complications, such as rhabdomyolysis. All self-reported hospital admissions for an injurious fall were confirmed by review of medical records and linkage to Medicare claims data. In addition to the 148 serious fall injuries that were ascertained through these procedures, 4 were identified through the Medicare claims data: 3 hip fractures (International Classification of Diseases, Ninth Revision [ICD-9] code 820.8) and 1 rib fracture (ICD-9 code 807.0). Twenty-two (14.5%) of the 152 serious fall injuries represented a second event. To enhance clinical interpretability, the current study focused on the first serious fall injury among 130 participants from the time of their enrollment through June 30, 2011.

Statistical Analysis
To identify functional trajectories before and after the serious fall injury, we used trajectory modeling, which is a form of latent class analysis. This method allowed us to simultaneously estimate each participant’s probabilities for membership in multiple trajectories, with assignment to a specific trajectory based on the highest probability of membership. We used PROC TRAJ in SAS software (SAS Institute), which fits a semiparametric (discrete) mixture model to longitudinal data using the maximum likelihood method. For each set of prefall and postfall trajectories, we modeled the total number of disabilities, ranging from 0 to 13, for 12 consecutive months as a zero-inflated Poisson distribution. The Bayesian information criterion was used to determine the number of prefall and postfall trajectories and whether each trajectory was best fit by intercept only or by linear, quadratic, or cubic terms. The adequacy of the final models was evaluated by using the average posterior probabilities of class membership; an average value of 0.9 or higher within each trajectory is considered an excellent fit, and less than 0.7 is considered a poor fit.

Next, we jointly modeled the number of disabilities for each month in the year before and after the serious fall injury (or through death) as a zero-inflated Poisson distribution. This allowed us to estimate the probabilities of membership in each postfall trajectory, conditional on membership in a given prefall trajectory. The probabilities were calculated with Bayes’ rule, and the corresponding 95% CIs were estimated with a first-order Taylor series expansion. The multivariable model was adjusted for age, sex, race, educational level less than high school, number of chronic conditions, cognitive impairment, depressive symptoms, and physical frailty, using data available immediately before the start of the prefall trajectory. These analyses were repeated separately for hip fractures and other serious fall injuries.

Finally, for each prefall trajectory, we calculated the difference between the number of disabilities in the month im-
mediated after the fall and the number in the month before the fall and the percentage of participants returning to their prefall level of function during the next year.

All analyses were performed using SAS software (version 9.2), and differences were considered statistically significant at $P < .05$ (2-tailed).

**Results**

Of the 130 serious fall injuries, 62 (47.7%) were hip fractures, 43 (33.1%) were other fractures (12 rib, 7 pelvis, 13 other lower extremity, 6 upper extremity, and 5 other), and 25 (19.2%) were nonfracture injuries (13 head trauma, 6 lower extremity, 2 upper extremity, and 4 other). Table 1 provides the characteristics of participants with a serious fall injury. Among all participants, the mean age at the time of hospitalization was 85.9 years; most participants were female and white, about a quarter did not complete high school, and about 1 in 13 were living in a nursing home. These characteristics did not differ significantly according to the type of serious fall injury. Before the start of the prefall trajectory, about half of the participants lived alone, less than a quarter had cognitive impairment or depressive symptoms, and nearly two-thirds were physically frail. On average, participants had 2 chronic conditions. Participants with a hip fracture were less likely to live alone but were otherwise comparable to those with another serious fall injury. At the start of the prefall trajectory, there were no substantive differences in the number of disabilities according to the type of injurious fall. However, a higher percentage of participants with hip fracture were living in a nursing home, although this difference did not achieve statistical significance.

![Figure 1](https://example.com/figure1.png)

As shown in Figure 1, 5 functional trajectories were identified in the year before the serious fall injury, and 4 were identified in the year after it. Before the fall, most participants had relatively flat but distinct levels of disability, ranging from no disability (the least common trajectory) to severe disability. For the progressive disability trajectory, the mean number of disabilities increased gradually during the year, from 5.4 at 12 months before the fall to 7.4 at 1 month before it. In the year after the fall, 4 distinct trajectories were identified, ranging from rapid recovery (the least common) to no recovery (the most common). The severity of disability immediately after the fall was highest for participants having no recovery, lowest for those having rapid recovery, and intermediate for those having gradual or little recovery. Although their initial severity of disability was higher, participants with gradual recovery did considerably better over time than those with little recovery.

Table 2 provides the unadjusted probabilities of the functional trajectories after the fall conditional on the prefall trajectories. For all falls, rapid recovery was observed only for participants who had no disability or mild disability before the fall; the probability of no recovery increased as the prefall functional trajectory worsened from no disability to severe disability; a substantive recovery, defined as rapid or gradual, was not observed for participants with progressive disability, and the probability of gradual recovery was highest for participants who had mild disability. Furthermore, whereas most participants with no disability before the fall had a rapid or gradual recovery, only about one-third of participants with moderate disability had a substantive recovery. Without exception, no recovery was observed among participants who had severe disability before the fall. Otherwise, the postfall functional trajectories were consistently worse after a hip fracture than after another serious fall injury. These differences were most pronounced among participants who had no disability before the fall; probabilities of a rapid recovery, gradual recovery, little recovery, and no recovery were 0.39, 0.22, 0.29, and 0.10, re-

### Table 1. Characteristics of 130 Participants With a Serious Fall Injury

| Characteristic                                      | All Participants (N = 130) | Hip Fracture (n = 62) | Other Injuries (n = 68) | P Value  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>85.9 (5.5)</td>
<td>86.2 (4.9)</td>
<td>85.6 (6.0)</td>
<td>.60</td>
</tr>
<tr>
<td>Female sex</td>
<td>95 (73.1)</td>
<td>45 (72.6)</td>
<td>50 (73.5)</td>
<td>.90</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>121 (93.1)</td>
<td>60 (96.8)</td>
<td>61 (89.7)</td>
<td>.11</td>
</tr>
<tr>
<td>Did not complete high school</td>
<td>36 (27.7)</td>
<td>18 (29.0)</td>
<td>18 (26.5)</td>
<td>.74</td>
</tr>
<tr>
<td>Nursing home resident</td>
<td>10 (7.7)</td>
<td>6 (9.7)</td>
<td>4 (5.9)</td>
<td>.42</td>
</tr>
<tr>
<td>Before start of prefall trajectory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lived alone</td>
<td>63 (48.5)</td>
<td>23 (37.1)</td>
<td>40 (58.8)</td>
<td>.01</td>
</tr>
<tr>
<td>No. of chronic conditions, mean (SD)</td>
<td>2.0 (1.3)</td>
<td>1.9 (1.5)</td>
<td>2.2 (1.2)</td>
<td>.17</td>
</tr>
<tr>
<td>Cognitive impairment†</td>
<td>28 (21.5)</td>
<td>12 (19.4)</td>
<td>16 (23.5)</td>
<td>.56</td>
</tr>
<tr>
<td>Depressive symptoms†</td>
<td>30 (23.1)</td>
<td>12 (19.4)</td>
<td>18 (26.5)</td>
<td>.34</td>
</tr>
<tr>
<td>Physically frail†‡</td>
<td>81 (62.3)</td>
<td>39 (62.9)</td>
<td>42 (61.8)</td>
<td>.89</td>
</tr>
<tr>
<td>Start of prefall trajectory</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of disabilities, mean (SD)‡</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All activities (0-13)</td>
<td>4.1 (3.6)</td>
<td>4.1 (3.9)</td>
<td>4.0 (3.4)</td>
<td>.86</td>
</tr>
<tr>
<td>Basic activities (0-4)</td>
<td>0.4 (1.0)</td>
<td>0.5 (1.1)</td>
<td>0.4 (0.9)</td>
<td>.63</td>
</tr>
<tr>
<td>Instrumental activities (0-5)</td>
<td>1.9 (1.8)</td>
<td>2.0 (1.9)</td>
<td>1.9 (1.7)</td>
<td>.64</td>
</tr>
<tr>
<td>Mobility activities (0-4)</td>
<td>1.7 (1.4)</td>
<td>1.7 (1.4)</td>
<td>1.8 (1.4)</td>
<td>.63</td>
</tr>
<tr>
<td>Nursing home resident</td>
<td>9 (6.9)</td>
<td>7 (11.3)</td>
<td>2 (2.9)</td>
<td>.06</td>
</tr>
</tbody>
</table>

* Data are given as number (percentage) of patients unless otherwise indicated.
† One participant (1.6%) had a synchronous fracture of the radius.
‡ For statistical comparisons between participants with a hip fracture and those with another injury, $\chi^2$ tests were used for dichotomous variables and $t$ tests for continuous variables.
§ Ascertained during comprehensive assessment immediately before the start of the prefall trajectory.
⋆ Defined as a score of less than 24 on the Mini-Mental State Examination.18
†† Defined as a score of at least 20 on the Center for Epidemiological Studies Depression Scale.19
‡‡ Defined on the basis of slow gait speed, as described in Methods.
††† Parenthetical ranges represent the number of possible disabilities for the set of activities.
Number and percentage of participants for each trajectory are shown in parentheses. The percentages may not sum to 100 because of rounding. The number of disabilities ranged from 0 to 13 based on 4 basic activities (bathing, dressing, walking inside the house, and transferring from a chair), 5 instrumental activities (shopping, housework, meal preparation, taking medications, and managing finances), and 4 mobility activities (walking a quarter mile, climbing a flight of stairs, lifting or carrying 10 lb, and driving). Dashed lines indicate identified trajectories; solid lines, predicted trajectories. The error bars represent 95% CIs for the predicted severity of disability. The average posterior probabilities of class membership for the trajectories before the fall were greater than 0.9, with values ranging from 0.92 for moderate to 0.98 for mild disability. All but 1 of the corresponding probabilities for the postfall trajectories were greater than 0.9, with values ranging from 0.89 for gradual to 0.99 for rapid recovery. The Bayesian information criterion was \(-6142.8\). Among participants with no recovery, little recovery, gradual recovery, or rapid recovery, the number (percentage) of deaths in the year after the fall was 20 (35%), 1 (4%), 4 (11%), and 0, respectively, and the median time to death was 5, 9, 1, and 0 months, respectively.

<table>
<thead>
<tr>
<th>Prefall Functional Trajectory</th>
<th>Type of Fall Injury</th>
<th>Postfall Functional Trajectory, Probability (95% CI)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No disability</td>
<td>All falls</td>
<td>0.45 (0.18-0.72) 0.38 (0.08-0.68) 0.11 (0.0-0.36) 0.06 (0.0-0.19)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hip fractures</td>
<td>0.39 (0.07-0.71) 0.22 (0.0-0.50) 0.29 (0.0-0.59) 0.10 (0.0-0.20)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other injuries</td>
<td>0.62 (0.18-1.06) 0.38 (0.0-0.72) 0.0 (0.0-0.0) 0.0 (0.0-0.0)</td>
<td></td>
</tr>
<tr>
<td>Mild disability</td>
<td>All falls</td>
<td>0.17 (0.02-0.32) 0.44 (0.24-0.64) 0.22 (0.05-0.39) 0.18 (0.04-0.31)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hip fractures</td>
<td>0.0 (0.0-0.01) 0.46 (0.14-0.78) 0.33 (0.03-0.63) 0.22 (0.0-0.44)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other injuries</td>
<td>0.26 (0.02-0.48) 0.33 (0.07-0.59) 0.27 (0.03-0.51) 0.14 (0.0-0.34)</td>
<td></td>
</tr>
<tr>
<td>Moderate disability</td>
<td>All falls</td>
<td>0.0 (0.0-0.0) 0.35 (0.11-0.59) 0.42 (0.18-0.66) 0.24 (0.04-0.44)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hip fractures</td>
<td>0.0 (0.0-0.0) 0.0 (0.0-0.0) 1.0 (1-1.0) 0.0 (0.0-0.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other injuries</td>
<td>0.0 (0.0-0.01) 0.63 (0.28-0.98) 0.26 (0.06-0.60) 0.11 (0.0-0.35)</td>
<td></td>
</tr>
<tr>
<td>Progressive disability</td>
<td>All falls</td>
<td>0.0 (0.0-0.0) 0.0 (0.0-0.0) 0.30 (0.06-0.54) 0.70 (0.46-0.94)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hip fractures</td>
<td>0.0 (0.0-0.0) 0.0 (0.0-0.0) 0.14 (0.0-0.34) 0.86 (0.66-1.06)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other injuries</td>
<td>0.0 (0.0-0.0) 0.06 (0.0-0.18) 0.59 (0.35-0.83) 0.36 (0.12-0.60)</td>
<td></td>
</tr>
<tr>
<td>Severe disability</td>
<td>All falls</td>
<td>0.0 (0.0-0.0) 0.0 (0.0-0.0) 0.0 (0.0-0.0) 1.0 (1-1.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hip fractures</td>
<td>0.0 (0.0-0.0) 0.0 (0.0-0.0) 0.0 (0.0-0.0) 1.0 (1-1.0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other injuries</td>
<td>0.0 (0.0-0.0) 0.0 (0.0-0.0) 0.0 (0.0-0.0) 1.0 (1-1.0)</td>
<td></td>
</tr>
</tbody>
</table>

\[\text{a} \text{ Joint trajectory models were analyzed separately for all falls, hip fractures, and other injuries, respectively, as described in Methods.}\]

\[\text{b} \text{ Point estimates represent average conditional posterior probability of membership; CIs were estimated by using a first-order Taylor series expansion.}\]

As shown in the eTable in the Supplement, the characteristics of participants differed considerably among the 5 prefall trajectories, with the least favorable characteristics observed in the severe disability group and the most favorable in the group with no disability. Figure 2 provides the probabilities of the postfall functional trajectories conditional on the prefall trajectories after accounting for these differences. For all falls, the adjusted point estimates, relative to the unadjusted values, tended to be slightly lower for rapid recovery and slightly higher for no recovery. In addition, there was a modest shift in probabilities from gradual recovery to little recovery for no disability, mild disability, and moderate disability. In each case, however, the adjusted point estimate was within the 95% CI of the unadjusted value. For hip fractures and other serious fall injuries, the adjusted results were comparable to those of the unadjusted analyses, with worse functional trajectories after the fall observed consistently among participants with a hip fracture. No covariate was signifi-

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**Figure 1. Functional Trajectories During the 12-Month Periods Before (A) and After (B) a Serious Fall Injury in 130 Participants**

![Diagram showing functional trajectories before and after a serious fall injury.](link_to_diagram)

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**Figure 2. Probability of Postfall Functional Trajectory, Probability (95% CI)**

- **Rapid Recovery**
  - No disability: 0.45 (0.18-0.72)
  - Hip fractures: 0.39 (0.07-0.71)
  - Other injuries: 0.62 (0.18-1.06)
- **Gradual Recovery**
  - No disability: 0.38 (0.08-0.68)
  - Hip fractures: 0.22 (0.0-0.50)
  - Other injuries: 0.38 (0.0-0.72)
- **Little Recovery**
  - No disability: 0.11 (0.0-0.36)
  - Hip fractures: 0.29 (0.0-0.59)
  - Other injuries: 0.0 (0.0-0.0)
- **No Recovery**
  - No disability: 0.06 (0.0-0.19)
  - Hip fractures: 0.10 (0.0-0.20)
  - Other injuries: 0.0 (0.0-0.0)
In this prospective study of older persons, we identified clinically distinct sets of functional trajectories immediately before and after a serious fall injury, and we evaluated the relationship between these 2 sets of trajectories according to the type of serious fall injury. We found that the functional trajectories after the fall were tightly linked to those before the fall for hip fractures and other serious injuries and that the postfall trajectories were consistently worse for hip fractures than for the other injuries. These results provide new information about the functional antecedents and consequences of serious fall injuries and underscore the critical importance of the prefall functional trajectory on the course of recovery after hip fracture and other serious fall injuries.

A serious fall injury is often a defining event in the life of an older person, demarcating 2 distinct epochs of function immediately before and after the injury. Although the course of recovery after a hip fracture has been well characterized,8-13 much less is known about functional outcomes after other serious fall injuries. Moreover, with few exceptions,28 most prior studies of hip fractures have evaluated the average course of functional recovery, despite evidence of the heterogeneity of this recovery13; and no prior study, to our knowledge, has attempted to characterize the course of disability before a serious fall injury or to evaluate its association with the course of recovery after the fall. The availability of monthly data on functional status over an extended period provided us with a unique opportunity to address these important gaps in knowledge.

Table 3. Change in Disability After Serious Fall Injury and Percentage of Participants Returning to Prefall Level of Function

<table>
<thead>
<tr>
<th>Prefall Functional Trajectory</th>
<th>Difference in No. of Disabilities, Median (IQR)*</th>
<th>Participants Returning to Prefall Level of Function, No. (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>No disability</td>
<td>9.0 (6.5-12.5)</td>
<td>9/16 (56)</td>
</tr>
<tr>
<td>Mild disability</td>
<td>9.0 (5.0-11.0)</td>
<td>14/34 (41)</td>
</tr>
<tr>
<td>Moderate disability</td>
<td>6.0 (4.0-8.0)</td>
<td>19/34 (56)</td>
</tr>
<tr>
<td>Progressive disability</td>
<td>4.0 (0.0-7.0)</td>
<td>10/23 (43)</td>
</tr>
<tr>
<td>Severe disability</td>
<td>2.0 (1.0-3.0)</td>
<td>14/23 (61)</td>
</tr>
</tbody>
</table>

Abbreviation: IQR, interquartile range.
* Difference between number of disabilities in the month immediately after the fall and number of disabilities in the month immediately before the fall.
* At any time during the 12-month follow-up period. Denominators represent total number in prefall disability category.
In the year before a serious fall injury, we identified 5 clinically distinct trajectories of disability, ranging from none to severe. With the exception of the progressive disability trajectory, the course of disability for each trajectory was relatively flat, suggesting that functional status for most older persons, though varying considerably from person to person, is relatively stable during the year before a serious fall injury. Immediately after the serious fall injury, we identified 4 clinically distinct trajectories of functional recovery, ranging from none to rapid. Although overlapping at the outset, the recovery curves for the other 2 trajectories (little and gradual) diverged after the first few months, distinguishing the few participants who had a substantive recovery from those who did not.

The probabilities of the postfall trajectories were greatly influenced by the prefall trajectories, such that rapid recovery was observed only among participants who had no disability or mild disability before the fall, and a substantive recovery was highly unlikely among those who had progressive or severe disability before the fall. Although these findings were observed for both types of serious fall injuries, the functional trajectories were consistently worse after a hip fracture than after another fall injury. Adjustment for relevant covariates had relatively little effect on the postfall probabilities, suggesting that the primary determinant of the postfall functional trajectory was the prefall functional trajectory.

Although participants with severe disability had the smallest decline in function after an injurious fall, they were no more likely to return to their prefall level of function than those with no disability, who had the largest decline in function. Whether recovery is defined on the basis of postfall trajectories or return to prefall level of function, our results indicate that serious fall injuries commonly occur in the setting of severe or progressive disability and that the adverse consequences of these events are attributable not only to the deleterious effects of the fall but also to the compromised functional state of older persons before the fall.

The current study provides detailed information about the functional antecedents and consequences of serious fall injuries, one of the most common causes of long-standing pain, disability, and death among older persons. Our findings can be used by physicians to advise their patients about the likely course of recovery after a serious fall injury. The strong association between the prefall and postfall functional trajectories suggests that the likelihood of recovery after a serious fall injury will be greatly constrained by the prefall trajectory, especially for hip fracture. Based on our findings, for example, palliative care might be recommended, in addition to rehabilitation, for patients who had moderate, progressive, or severe disability before a hip fracture.

In contrast, among patients who had no disability or mild disability before their serious fall injury, more aggressive rehabilitation could be pursued to enhance the likelihood of a rapid recovery. Although additional development work is needed, prior research suggests that premorbid functional status can be successfully ascertained over 6 to 12 months.

Our study included monthly assessments of functional status over an extended period, with few missing data and few losses to follow-up for reasons other than death. To our knowledge, comparable data are available in no other study. Additional strengths of the study include the use of medical records and Medicare claims data to confirm all hospitalizations for a fall-related injury and an analytic strategy that distinguished between hip fractures and other serious fall injuries.

Nonetheless, our results should be interpreted in the context of several potential limitations. First, the functional trajectories were based on self-reported information rather than objective measures of physical capabilities, such as the 6-minute walk, which has been used in prior studies to evaluate functional outcomes after a hip fracture. The frequency of our assessments necessitated the use of self-reported function, which included a comprehensive array of basic, instrumental, and mobility activities with demonstrated reliability. Second, information was not available on receipt of restorative interventions that could have altered the course of recovery after the serious fall injury. Third, it was not possible to determine how the functional trajectories might differ in the non–hip fracture group according to type of injury, given the small numbers in the subgroups.

Finally, because our study participants were members of a single health plan in a small urban area and were oversampled for physical frailty, our results may not be generalizable to older persons in other settings. However, the demographic characteristics of our cohort reflect those of older persons in New Haven County, Connecticut, which are similar to the characteristics of the US population as a whole, with the exception of race or ethnicity. Moreover, because serious fall injuries were identified within the context of an ongoing longitudinal study, with few exclusion criteria and a high participation rate, our results may be more generalizable than those of prior studies that have enrolled an inception cohort of older patients who survived their hip fracture or other fall-related injury, met the relevant inclusion and exclusion criteria, and agreed to participate.

In summary, the functional trajectories immediately before and after a serious fall injury are quite varied but highly interconnected. The tight link between the prefall and postfall functional trajectories suggest that the course of recovery after a serious fall injury may not improve for many older persons without increased attention to their prefall functional trajectory.
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REFERENCES


Invited Commentary

Prognosis for Recovery After Injurious Falls
Clinical and Policy Implications of Varying Definitions of Recovery

Stephanie Studenski, MD, MPH

Hip fractures and other serious injuries attributed to falls have dire consequences for increased mortality and decreased function. Although prevention is surely the best strategy, substantial resources are justifiably invested in promoting recovery after such events—but who should receive such costly interventions? Clearly, treatment should be aligned with expectation of benefit. Common markers of vulnerability among the aged, such as disability and cognitive impairment, are strongly associated with worse survival and functional decline after hip fracture and other adverse health events associated with aging, including hospitalization and cancer. Given that ethical decision making should be driven by the goals and best interests of the patient, what is the best approach to patient care for an older adult after a serious fall injury?

The article by Gill et al in the current issue provides a unique window into the course of function before and after serious fall injury. Although postinjury function is known to be influenced by premorbid function, to my knowledge, no prior studies have addressed the unique window into the course of function before and after hip fracture and other adverse health events associated with aging, including hospitalization and cancer. Given that ethical decision making should be driven by the goals and best interests of the patient, what is the best approach to patient care for an older adult after a serious fall injury?

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