Restricted Activity and Functional Decline Among Community-Living Older Persons

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Background: Restricted activity is common among community-living older persons, but its prognostic significance is not known. We performed a prospective cohort study to evaluate the association between the occurrence of restricted activity and functional decline over an 18-month period.

Methods: We studied 680 community-living persons, 70 years or older, who were categorized into 3 groups according to their risk for disability (low, intermediate, or high) in activities of daily living (ADL). Participants were subsequently followed up with monthly telephone interviews to ascertain the occurrence of restricted activity, defined as having stayed in bed for at least half a day and/or having cut down on their usual activities due to an illness, injury, or other problem in the past month. Functional decline was defined as an increase in ADL disability scores between the baseline and 18-month follow-up assessments, which were completed in the home.

Results: After adjusting for the baseline risk of disability and other covariates, the disability score at 18 months increased (ie, worsened) by 11.2% (95% confidence interval [CI], 7.0%-15.6%) for each additional month with restricted activity. The association between restricted activity and functional decline differed significantly by risk group (P<.001). For the low- and intermediate-risk groups, the adjusted disability scores increased by 18.7% (95% CI, 10.3%-27.8%) and 7.5% (95% CI, 2.7%-12.5%), respectively, for each additional month with restricted activity. There was no association between restricted activity and functional decline in the high-risk group, as evidenced by a nonsignificant increase in the adjusted disability score of 2.7% (95% CI, −6.6% to 12.9%).

Conclusion: For older persons who are not otherwise at high risk for ADL disability, restricted activity is an important predictor of functional decline and not just a benign feature of old age.

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In a recently published report, we found that restricted activity, defined as staying in bed for at least half a day and/or cutting down on one's usual activities because of an illness, injury, or other problem, is common among community-living older persons, regardless of risk for disability, and is usually attributable to several concurrent health-related problems. Over a median follow-up of 15 months, for example, about 3 of every 4 persons reported restricted activity during at least 1 month, and nearly 40% reported restricted activity during 2 consecutive months. While restricted activity has face validity as a measure of health and functional status, its prognostic significance is unknown. Some investigators have questioned, for example, whether restricted activity is really a key marker of functional decline or merely an indicator of intermittent difficulty in the performance of usual activities, ie, “just having a bad day.”

To answer this question, we evaluated the association between the occurrence of restricted activity and functional decline over an 18-month period using a prospective cohort design. We hypothesized that restricted activity, rather than being a benign feature of old age, is an independent predictor of functional decline among community-living older persons.

Participants were members of the Precipitating Events Project, a longitudinal study of 754

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From the Department of Internal Medicine, Yale University School of Medicine, New Haven, Conn. The authors have no relevant financial interest in this article.

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community-living persons aged 70 years or older. Exclusion criteria included the following: need for personal assistance in any of 4 key activities of daily living (ADL)—bathing, dressing, walking inside the house, and transferring from a chair; significant cognitive impairment with no available proxy; inability to speak English; diagnosis of a terminal illness with a life expectancy less than 12 months; and plan to move out of the New Haven, Conn, area during the next 12 months.

The assembly of the cohort, which took place between March 1998 and October 1999, has been described in detail elsewhere. In brief, potential participants were identified from a computerized list of 3157 age-eligible members of a large health plan in greater New Haven. Eligibility was determined during a screening telephone interview and was confirmed during an in-home assessment. Participants were enrolled in a 4:2:1 ratio for low, intermediate, and high risk for ADL disability, using a model developed and validated in an earlier study. Participants were classified as low risk if they scored 10 seconds or less on the rapid gait test (ie, walk back and forth over a 10-ft [3-m] course as quickly as possible); as intermediate risk if they scored greater than 10 seconds on the rapid gait test, scored 24 or better on the Folstein Mini-Mental State Examination (MMSE), and were younger than 85 years; and as high risk if they scored greater than 10 seconds on the rapid gait test and had either scored less than 24 on the MMSE or were aged 85 years or older. Only 4.6% of the 2753 health plan members who were alive and could be contacted refused to complete the screening telephone interview, and 75.2% of the eligible members agreed to participate in the project, which was approved by the Human Investigation Committee at Yale University.

Of the 754 participants, 46 (6.1%) died, 27 (3.6%) refused to complete the 18-month follow-up assessment, and 1 (0.1%) had no assessment of restricted activity because of an administrative error. The remaining 680 (90.2%) participants constituted the analytic sample for the present study. Compared with these participants, those who were not included in the analytic sample were older (80.3 vs 78.2 years; P = .001), were more likely to be in the high-risk group (29.7% vs 12.6%; P = .001), and were less likely to be in the low-risk group (40.3% vs 99.1%; P = .002).

DATA COLLECTION
Baseline and 18-month follow-up assessments were completed in the home, while monthly assessments of restricted activity were completed over the telephone. All assessments were carried out by trained research staff who underwent intensive training and followed standard procedures outlined in a detailed training and coding manual. Standardization of assessments and measurements of interrater reliability verified the consistency of ratings. The research nurses who completed the follow-up home assessments were kept blinded to the results of the monthly assessments. Because of scheduling problems or other logistical issues (eg, participants wintering in Florida), 45 (6.6%) of the 18-month follow-up assessments were completed outside the desired 2-month window.

ASSESSMENT OF COVARIATES
In addition to cognitive status and gait speed, data were collected at baseline on demographic characteristics, including age, sex, race/ethnicity, education, and living situation, and on 13 self-reported, physician-diagnosed chronic conditions: hypertension; myocardial infarction; congestive heart failure; stroke; diabetes mellitus; arthritis; hip fracture; fracture of wrist, arm, or spine since age 50 years; amputation of leg; chronic lung disease; cirrhosis or liver disease; cancer (other than minor skin cancers); and Parkinson disease.

FUNCTIONAL DECLINE
Functional decline was defined as an increase in ADL disability scores between the baseline and 18-month follow-up assessments. Self-reported information was collected on 7 ADL: bathing, dressing, walking inside the house, transferring from a chair, toileting, feeding, and grooming. For each ADL task, participants were asked, “At the present time, do you need help from another person to complete the task?” Participants who did not need help were subsequently asked, “At the present time, do you have difficulty with the task?” Based on the results of an earlier study, each task was scored as “0” for no help and no difficulty, “1” for difficulty but no help, and “2” for help regardless of difficulty; and a summary ADL disability score (hereafter referred to simply as disability score) was created with a range of 0 (no disability) to 14 (total disability). The test-retest reliability of this disability scale was found to be excellent, with an intraclass correlation coefficient of 0.86.

ASSESSMENT OF RESTRICTED ACTIVITY
Each month between the baseline and 18-month follow-up assessments, participants were asked 2 questions related to restricted activity using a standardized protocol with high reliability: (1) “Since we last talked on [date of last interview], have you cut down on your usual activities due to an illness, injury, or other problem?” and (2) “Since we last talked on [date of last interview], have you stayed in bed for at least half a day due to an illness, injury, or other problem?” Because relatively little is known about the functional consequences of restricted activity, we considered 2 exposure definitions. In the first, referred to hereafter as the “standard” definition, participants were considered to have restricted activity during a specific month if they answered yes to one or both of the questions. In the second, referred to hereafter as the “alternative” definition, participants were considered to have restricted activity during a specific month only if they answered yes to both of the questions. Follow-up data on restricted activity were available for 99.1% of the 12,186 scheduled monthly assessments. The mean (SD) number of completed assessments for the low-, intermediate-, and high-risk groups were 18.1 (0.8), 17.9 (1.0), and 17.7 (0.9), respectively.

STATISTICAL ANALYSIS
Based on the distribution of the data, we used a negative binomial regression model to evaluate the association between restricted activity and functional decline as previously defined. The dependent variable was the disability score at 18 months. The primary explanatory variable was the number of months with restricted activity between the baseline and 18-month follow-up assessments. The covariates included sex (female vs male), race/ethnicity (Non-Hispanic white vs other), living situation (alone vs with others), and risk group (intermediate vs low and high vs low), which were each analyzed as a dichotomous variable that was coded as 1 vs 0, and years of education, number of chronic conditions, and baseline disability score, which were each analyzed as a continuous variable. By modeling the disability score at 18 months and controlling for baseline disability, the resulting coefficients reflect the expected change in the 18-month disability scores. To minimize the deleterious effects of collinearity and overadjustment, we did not include age and MMSE score in the regression models because these variables were used to form the risk group classification.

For the primary explanatory variable and each of the covariates, we estimated the parameters (ie, β coefficients) us-
ing the negative binomial regression model and calculated the percentage (ie, relative) change in disability scores per each unit increment as $100 \times \frac{e^{\beta} - 1}{e^{\beta}}$. A positive value for the percentage change indicates an increase in disability between the baseline and 18-month follow-up assessments. To address the potential concern that functional decline might precede rather than follow restricted activity, we repeated these analyses using 2 alternative exposure periods. We considered exposure to restricted activity during the first 12 months and subsequently during the first 6 months. In each case, the dependent variable was the disability score at 18 months as previously described. This analytic technique, which has been used previously to support the temporal relationship between falls/fall injuries and functional decline, increases the likelihood that changes in ADL function occurred after the restricted activity. As a second mechanism to strengthen temporal precedence, we evaluated the association between restricted activity and functional decline among the subgroup of participants who had no disability at baseline. Finally, after testing for an interaction, we evaluated the association between restricted activity and functional decline separately for each of the 3 risk groups and subsequently calculated the least-square means of the 18-month disability scores, adjusted for baseline disability and other covariates, by risk group and months with restricted activity.

All statistical tests were 2-tailed, and $P<.05$ was considered to indicate statistical significance. All analyses were performed using SAS version 8.1 (SAS Institute, Cary, NC).

The baseline characteristics of the 680 participants are shown in Table 1. As expected, based on our risk model for disability, participants in the high-risk group were older and had lower MMSE scores than participants in the low- and intermediate-risk groups. Participants in the low-risk group were the least likely to be female and to live alone and had the highest education and the lowest burden of chronic conditions and disability.

Table 1. Baseline Characteristics of Study Participants*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall (N = 680)</th>
<th>Low (n = 402)</th>
<th>Intermediate (n = 192)</th>
<th>High (n = 86)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>78.2 ± 5.2</td>
<td>76.8 ± 4.6</td>
<td>78.2 ± 3.8</td>
<td>84.8 ± 5.1</td>
</tr>
<tr>
<td>Female</td>
<td>443 (65.1)</td>
<td>244 (60.7)</td>
<td>141 (73.4)</td>
<td>58 (67.4)</td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>614 (90.3)</td>
<td>371 (92.3)</td>
<td>168 (87.5)</td>
<td>75 (87.2)</td>
</tr>
<tr>
<td>Lives alone</td>
<td>270 (39.7)</td>
<td>138 (34.3)</td>
<td>92 (47.9)</td>
<td>40 (46.5)</td>
</tr>
<tr>
<td>Education, y</td>
<td>12.0 ± 2.8</td>
<td>12.5 ± 2.8</td>
<td>11.6 ± 2.7</td>
<td>10.7 ± 2.9</td>
</tr>
<tr>
<td>Chronic conditions</td>
<td>1.8 ± 1.3</td>
<td>1.6 ± 1.2</td>
<td>2.2 ± 1.3</td>
<td>1.9 ± 1.3</td>
</tr>
<tr>
<td>MMSE† score</td>
<td>26.8 ± 2.4</td>
<td>27.2 ± 2.3</td>
<td>27.3 ± 1.7</td>
<td>24.2 ± 2.9</td>
</tr>
<tr>
<td>Disability score‡</td>
<td>0.4 ± 0.9</td>
<td>0.2 ± 0.6</td>
<td>0.6 ± 1.1</td>
<td>0.7 ± 1.2</td>
</tr>
</tbody>
</table>

*Data are given as mean ± SD or number (percentage) of participants.
†Folstein Mini-Mental State Examination.
‡See the “Methods” section for description of scale.

Table 2. Exposure to Restricted Activity During the 18-Month Follow-up Period

<table>
<thead>
<tr>
<th>Risk for Disability</th>
<th>Overall (N = 680)</th>
<th>Low (n = 402)</th>
<th>Intermediate (n = 192)</th>
<th>High (n = 86)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Proportion with exposure</td>
<td>0.84</td>
<td>0.80</td>
</tr>
<tr>
<td>Standard Definition of Restricted Activity*</td>
<td>0.84</td>
<td>0.80</td>
<td>0.90</td>
<td>0.86</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>4.3 ± 3.2</td>
<td>3.8 ± 2.8</td>
<td>5.2 ± 3.7</td>
<td>4.3 ± 3.2</td>
</tr>
<tr>
<td>Median</td>
<td>3.0</td>
<td>3.0</td>
<td>4.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Range</td>
<td>1-16</td>
<td>1-16</td>
<td>1-16</td>
<td>1-16</td>
</tr>
<tr>
<td>Alternative Definition of Restricted Activity†</td>
<td>0.57</td>
<td>0.52</td>
<td>0.67</td>
<td>0.62</td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>2.6 ± 2.3</td>
<td>2.3 ± 1.7</td>
<td>3.1 ± 2.7</td>
<td>2.8 ± 2.6</td>
</tr>
<tr>
<td>Median</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>Range</td>
<td>1-13</td>
<td>1-13</td>
<td>1-13</td>
<td>1-13</td>
</tr>
</tbody>
</table>

*Cut down on usual activities or stay in bed for at least half a day.
†Cut down on usual activities and stay in bed for at least half a day.
‡Among participants with at least 1 month of exposure.
The most potent predictor of functional decline, not surprisingly, was the previously validated risk model for disability. Nonetheless, after adjusting for the risk of disability and the other covariates, the disability scores increased (ie, worsened) by 11.2% and 16.4%, respectively, for each additional month with restricted activity by the standard and alternative definitions. When exposure to restricted activity was limited to the first 6 and 12 months, respectively, the corresponding values were 19.8% (95% confidence interval [CI], 9.6%-30.8%) and 30.4% (95% CI, 16.0%-46.7%), and 11.7% (95% CI, 5.8%-18.0%) and 18.7% (95% CI, 9.8%-28.8%). Finally, among the 527 participants who had no disability at baseline, the disability scores increased by 17.9% (95% CI, 11.6%-24.6%) and 20.5% (95% CI, 11.3%-30.5%), respectively, for each additional month with restricted activity by the standard and alternative definitions.

The association between restricted activity and functional decline differed significantly by risk group (P<.001 for both the standard and alternative definitions). For the low-risk group, the adjusted disability scores increased by 18.7% (95% CI, 10.3%-27.8%) and 28.2% (95% CI, 14.4%-43.7%), respectively, for each additional month with restricted activity by the standard and alternative definitions. For the intermediate-risk group, the corresponding values were 7.5% (95% CI, 2.7%-12.5%) and 9.8% (95% CI, 2.9%-17.1%). There was no association between restricted activity and functional decline in the high-risk group, as evidenced by nonsignificant increases in the adjusted disability scores of 2.7% (95% CI, -6.6% to 12.9%) for the standard definition and 6.1% (95% CI, -6.9% to 20.9%) for the alternative definition.

The mean disability scores at 18 months, adjusted for baseline disability and other covariates, are provided in Table 4 for each of the 3 risk groups according to the number of months with restricted activity. The disability scores increased monotonically for the low-risk group as the number of months with restricted activity increased. A similar phenomenon was observed for the intermediate-risk group except that participants with no restricted activity had higher disability scores than participants with 1 or 2 months with restricted activity. For the high-risk group, there was no significant trend for

for the alternative definition than for the standard definition and differed only modestly by risk group.

At 18 months, the mean (SD) disability scores for the low-, intermediate-, and high-risk groups were 0.49 (0.70), 1.80 (2.25), and 2.55 (3.01), respectively. The percentage change in disability scores between the baseline and 18-month follow-up assessments is provided in Table 3 for each of the baseline characteristics and for the number of months with restricted activity. In both sets of multivariable models, the factors that were statistically associated with change in disability scores, ie, functional decline, included the baseline disability score, intermediate and high risk for disability (compared with low risk), and the number of months with restricted activity. The most potent predictor of functional decline,
the disability scores as the number of months with restricted activity increased.

**COMMENT**

In this prospective cohort study of community-living older persons, we found a strong and independent association between the occurrence of restricted activity and functional decline over an 18-month period. This association was maintained for exposure periods of 6 and 12 months, thereby supporting temporal precedence, but was not observed among the frailest subgroup of older persons who had high rates of functional decline even in the absence of restricted activity. These results suggest that for most older persons, restricted activity is an important predictor of functional decline and not just a benign feature of old age.

We have previously demonstrated that restricted activity is common among community-living older persons regardless of risk for disability. In the present study, most participants had at least 1 month with restricted activity by the standard definition, which required cutting back on one's usual activities or staying in bed for at least half a day, and about one half to two thirds had at least 1 month with restricted activity by the alternative definition, which required cutting back on one's usual activities and staying in bed for at least half a day. For both definitions, it was not uncommon for participants to have several months with restricted activity during the 18-month follow-up period. Not surprisingly, the alternative definition represented the more potent exposure, with disability scores increasing by 16.4% for each additional month with restricted activity compared with 11.2% for the standard definition. The high incidence of restricted activity and its strong association with functional decline highlight its potential importance as a target for preventive and restorative interventions.

The lack of association between restricted activity and functional decline among participants at high risk for disability may be explained, in part, by the relatively high rate of attrition, particularly from deaths, in this subgroup of frail older persons. Of the original 108 participants in the high-risk group, 14.9% died and 6.5% did not complete the 18-month follow-up assessment, compared with 4.2% and 2.8% in the low-risk group and 6.1% and 4.2% in the intermediate-risk group. Because most deaths among older persons are preceded by functional decline and disability, and because decedents in the high-risk group had rates of restricted activity that were comparable to those reported in Table 2 despite a shorter length of follow-up (data not shown), a true association between restricted activity and functional decline in the high-risk group may have been missed. Alternatively, by virtue of their severe frailty, older persons at high risk may develop functional decline and disability insidiously, ie, in the absence of a precipitating event. In the present study, 41.7% of the high-risk participants who reported no restricted activity actually experienced functional decline over the 18-month follow-up period, compared with 6.3% of the low-risk participants (P = .003).

While we found that restricted activity was associated with large relative declines in functional status, the absolute changes in disability scores were modest. Nonetheless, these changes, which were likely attenuated by the exclusion of decedents, are comparable to those that have been reported in the setting of recurrent and injurious falls and are likely to be clinically meaningful given the enormous costs and morbidity associated with functional decline and disability among older persons. While the relative changes in disability scores were smaller in the intermediate-risk group than in the low-risk group, the absolute changes were larger, reflecting the higher disability scores at 18 months among participants in the intermediate-risk group. Because of small numbers, the mean disability scores among participants in the intermediate- and high-risk groups who had no restricted activity were susceptible to the effects of "extreme" values (ie, outliers), which may explain in part why these participants had higher disability scores than the corresponding participants who had 1 to 2 months of restricted activity.

As is true for any observational study, we cannot firmly establish a cause-effect relationship between restricted activity and functional decline. Our multivariable models adjusted for the most relevant factors, particularly risk for disability, that may have confounded the relationship between restricted activity and functional decline. Furthermore, the strong linear trends observed for the low- and intermediate-risk groups support a "dose-response" relationship. Temporal precedence—ensuring that the exposure (restricted activity) preceded the outcome (functional decline)—is supported by the persistence of strong independent associations when exposure to restricted activity was limited to the first 6 and 12 months, respectively, and when the analysis was restricted to participants who had no disability at baseline.

Nonetheless, in the absence of repeated serial measurements of both the exposure and the outcome, we cannot determine definitively that restricted activity preceded functional decline. It is possible, for example, that a reciprocal relationship exists between restricted activity and functional decline such that one begets/worsens the other, leading to a progressive downhill course in some individuals. While a single disease process could lead to both restricted activity and functional decline, we have previously found that older persons usually attribute their restricted activity to several concurrent health-related problems, including (most commonly) fatigue, pain or stiffness in the back or joints, and dizziness or unsteadiness while standing. Although the present study was not designed to determine the mechanisms by which restricted activity might lead to functional decline, for many older persons it is likely that reductions in activities and bed rest contribute to a general deconditioning and to an accelerated loss of muscle strength, which together may lead to functional decline and disability.

Because our participants were members of a single health plan in a small urban area, our findings may not be generalizable to older persons in other settings. Generalizability, however, depends not only on the choice of a study population but also on the stability of the population over time. One of the great strengths of our study is the high follow-up rate, with successful completion of over 99% of the monthly telephone interviews and over
96% of the 18-month follow-up assessments. The generalizability of our findings is also enhanced by our high participation rate, which was greater than 75%.

In summary, our results indicate that restricted activity for most older persons represents more than just having a bad day. Given its high incidence and strong association with functional decline, restricted activity warrants further investigation as a potential target of preventive and restorative interventions.

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