Journal of Gerontology: MEDICAL SCIENCES
2004, Vol. 59A, No. 7, 755–761

The Deleterious Effects of Bed Rest Among Community-Living Older Persons

Thomas M. Gill, Heather Allore, and Zhenchao Guo

Yale University School of Medicine, Department of Internal Medicine, New Haven, Connecticut.

Background. Older persons often ''take to bed'' while they are ill or injured, but relatively little is known about the functional consequences of bed rest among community-living older persons. In this prospective cohort study, the association between episodes of bed rest and functional decline was evaluated during an 18-month period.

Methods. Participants included 680 nondisabled, community-living persons aged 70 years or older. They were separated into 2 groups according to the presence or absence of physical frailty, which was defined based on slow gait speed. Episodes of bed rest were ascertained each month in a telephone interview for a median of 18 months. The completion rate was 99.1%. Functional decline was defined as a worsening in scores between the baseline and 18-month follow-up assessments in 1 or more of the following measures: instrumental activities of daily living, mobility, physical activity, and social activity.

Results. Among the 404 (59.4%) participants who had at least 1 episode of bed rest, the mean number of months with bed rest was 2.8 (standard deviation, 2.4). After adjustments were made for several potential confounders, the number of months with bed rest was significantly associated with decline in each of the functional measures. Significant associations were also observed for each of the functional outcomes among participants who were not physically frail, but they were observed only for instrumental activities of daily living disability among participants who were physically frail.

Conclusions. These findings indicate that episodes of bed rest among community-living older persons are associated with decline in several important indicators of function.

WHEN they are ill or injured, older persons often ''take to bed''; yet, surprisingly little is known about the functional consequences of bed rest among community-living older persons. Among hospitalized elderly persons, bed rest and immobilization contribute to several iatrogenic disorders, including pressure sores, deep venous thromboses, and incontinence, and commonly lead to functional decline and disability (1–3). Studies of healthy young men have shown that prolonged bed rest has deleterious effects on nearly every organ system (4,5). Older persons, by virtue of their diminished reserve capacity (6), may be vulnerable to adverse functional outcomes even when exposed to relatively brief episodes of bed rest.

The goal of this study was to determine the functional consequences of bed rest among community-living older persons. We used data from a prospective cohort study to evaluate the association between episodes of bed rest, which were ascertained monthly, and decline during an 18-month period in several important indicators of function, including instrumental activities of daily living (IADLs), mobility, physical activity, and social activity.

Methods

Study Population

Participants were members of the Precipitating Events Project, a longitudinal study of 754 community-living persons aged 70 years or older (7). Exclusion criteria included the need for personal assistance in any of 4 key activities of daily living—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, Connecticut area during the next 12 months.

The cohort was assembled between March 1998 and October 1999 and has been described in detail in another publication (7). Briefly, potential participants were identified from a computerized list of 3157 age-eligible members of a large health plan in greater New Haven, Connecticut. Eligibility was determined during a screening telephone interview and was confirmed during an in-home assessment. Persons who were physically frail, as denoted by a score of more than 10 seconds on the rapid gait test (i.e., walking back and forth over a 10-foot course as quickly as possible), were oversampled to ensure a sufficient number of participants at increased risk for functional decline (8,9). Slow gait speed has been shown in several different populations to be the single best predictor of functional decline and disability (8,10,11). 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 assessments for bed rest because of an administrative error. The remaining 680 (90.2%) participants constituted the analytic sample for the current study. Compared with these participants, those who were not included in the analytic sample were older (80.3 vs 78.2

years; $p = .001$) and more likely to be physically frail (59.5% vs 40.9%; $p = .002$).

Data Collection

The baseline and 18-month follow-up assessments were completed in the home, whereas the monthly assessments of bed rest were completed in a telephone interview. All assessments were performed by research staff who underwent intensive training and followed standard procedures outlined in a detailed training and coding manual. Standardization of assessments and measurements of inter-rater 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 (e.g., participants wintering in Florida), 45 (6.6%) of the 18-month follow-up assessments were completed outside of the desired 2-month window.

Assessment of Covariates

In addition to gait speed, data were collected at baseline on demographic characteristics, including age, sex, race/ethnicity, education, and living situation; cognitive status as assessed by the Folstein Mini-Mental State Examination (12); depressive symptoms as assessed by the Center for Epidemiologic Studies Depression scale (13); and 13 self-reported, physician-diagnosed chronic conditions: hypertension; myocardial infarction; congestive heart failure; stroke; diabetes; 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's disease. Participants were considered to be cognitively impaired if they scored less than 24 on the Mini-Mental State Examination (12) and to have depressive symptoms if they scored 16 or more on the Center for Epidemiologic Studies Depression scale (13,14). Data on the covariates were 100% complete.

Assessment of Bed Rest

Each month between the baseline and 18-month follow-up assessments, participants were asked, ''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?'' The test-retest reliability of this assessment was high, with a Kappa statistic of 0.84 for the presence or absence of bed rest. Follow-up data on bed rest were available for 99.1% of the 12,186 scheduled monthly assessments. The mean number of completed assessments for each participant was 18.1 (standard deviation [*SD*], 0.8).

Assessment of Functional Decline

Functional decline was defined as a worsening in scores between the baseline and 18-month follow-up assessments in 1 or more of the following measures: IADLs, mobility, physical activity, and social activity. The 5 IADL tasks—shopping, housework, meal preparation, taking medications, and managing finances—were scored as 0 for no (personal) help and no difficulty, 1 for difficulty but no help, or 2 for help regardless of difficulty (15). A summary IADL disability score was created with a range of 0 (no disability) to 10 (total disability). The mobility scale included 3 tasks—walking inside the home, walking one-quarter mile, and walking up a flight of stairs—that were scored as 0, 1, or 2, based on the need for help or difficulty, and a fourth item that was also scored as 0, 1, or 2, based on the average amount of time (in hours) walked per day (>0.75, 0.25–0.75, or <0.25). A summary mobility disability score was created with a range of 0 (no disability) to 8 (total disability).

Physical activity was assessed using the Physical Activity Scale for the Elderly (PASE) (16,17). The PASE assesses several occupational, household, and leisure activities during a 1-week period. The PASE score is computed by multiplying the amount of time spent in each activity by the item weights, which were empirically derived, and summing over all activities; total scores range from 0 to 370 (best score). Both the reliability and validity of the PASE have been demonstrated (16,18,19). To better reflect habitual activity, we modified the PASE by asking about activities during a typical week in the last month instead of activities during the past week. Ten groups of social activities (attending events; trips; paid work; volunteering; visiting friends; attending religious services; participating in groups; going to museums or shows; caring for or helping a friend or relative; and talking on the telephone with friends, neighbors, and relatives) were assessed using a protocol adapted from the Established Populations for Epidemiologic Studies of the Elderly interview (20). Scores for each activity were based on the frequency of participation (i.e., 0 for less than once a month, 1 for 1 to 4 times per month, and 2 for more than 4 times per month), and a social activity score, with a range from 0 to 20 (best score), was derived by summing the frequency ratings for each of the 10 groups of activities (21).

One participant had missing data at 18 months on the physical and social activity measures. Data on functional decline were otherwise 100% complete.

Statistical Analyses

We calculated descriptive statistics for the baseline characteristics and for exposure to bed rest during the 18-month follow-up period. When we compared participants who were physically frail with those who were not, we used the chi-square test for categorical variables and the *t* test for continuous variables. We generated box plots to characterize the baseline and 18-month scores for the 4 functional measures and used a nonparametric Wilcoxon's rank test to evaluate differences between the 2 frailty groups.

To evaluate the association between bed rest and functional decline, we used a series of regression models that provided the best fit to the data (22). For each model, the dependent variable was the score at 18 months for the specific functional measure. The primary explanatory variable was the number of months with bed rest 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), physical frailty (yes vs no), cognitive impairment (yes vs no), and depressive symptoms (yes vs no), which were each analyzed as a dichotomous variable, and years of education, number of chronic conditions, and the baseline

Table 1. Baseline Characteristics of Study Participants*

Characteristic	Overall ($N = 680$)	Physically Frail: No ($N = 402$)	Physically Frail: Yes ($N = 278$)	p Value
Age (y), mean	78.2 ± 5.2	76.8 ± 4.6	80.2 ± 5.2	<.001
Female, *n* (%)	443 (65.1)	244 (60.7)	199 (71.6)	.003
Nonhispanic white, *n* (%)	614 (90.3)	371 (92.3)	243 (87.4)	.037
Lives alone, *n* (%)	270 (39.7)	138 (34.3)	132 (47.5)	<.001
Education (y), mean	12.0 ± 2.8	12.5 ± 2.8	11.3 ± 2.8	<.001
Chronic conditions, mean	1.8 ± 1.3	1.6 ± 1.2	2.1 ± 1.3	<.001
Cognitively impaired†, *n* (%)	71 (10.4)	30 (7.5)	41 (14.7)	.002
Depressive symptoms‡, *n* (%)	134 (19.7)	56 (13.9)	78 (28.1)	<.001

Notes: *All means are expressed ± *SD* (standard deviation); the *t* test and chi-square test were used to evaluate differences in means and percentages, respectively.

†Defined as a score of less than 24 on the Folstein Mini-Mental State Examination (12).

‡Defined as a score of 16 or higher on the Center for Epidemiologic Studies Depression Scale (13,14).

Table 2. Exposure to Bed Rest During 18-Month Follow-Up Period

Number of Months With Bed Rest*	Overall ($N = 680$)	Physically Frail: No ($N = 402$)	Physically Frail: Yes ($N = 278$)
	Percentage of Participants†		
None	40.6	46.0	32.7
One	23.2	21.6	25.5
Two to three	21.2	21.9	20.1
Four or more	15.0	10.4	21.6

Notes: *$p < .001$ by chi-square test for difference between the two frailty groups.

†Values in each column may not add up to 100 because of rounding.

score of the specific functional measure, which were each analyzed as a continuous variable. By modeling the score at 18 months and controlling for the baseline score, the resulting coefficients reflect the expected change in the 18-month score for the specific functional measure.

Because the physical activity scores were not normally distributed, they were first transformed using the square root and subsequently analyzed using multiple linear regression. Both baseline and 18-month mean monthly temperatures were included as covariates based on previous research showing strong seasonal effects on physical activity (16). For the other functional measures, scores were discrete and followed a negative binomial distribution. Thus, we estimated the parameters (i.e., β coefficients) using the negative binomial regression model (22). Finally, for each of the 4 measures we evaluated the association between bed rest and functional decline separately for participants who were physically frail and for those who were not physically frail, and we calculated the least-square means of the 18-month scores, adjusted for baseline scores and other covariates, by frailty group and months with bed rest. To facilitate the presentation of our results, we considered IADLs and mobility to be measures of disability and physical and social activity to be measures of ability.

All statistical tests were 2-tailed, and probability values less than 0.05 were considered significant. The box plots were created using S-PLUS version 6.0 (23). All other analyses were performed using SAS version 8.2 (24).

Results

Table 1 shows the baseline characteristics of the 680 participants. Those who were physically frail were older; were more likely to be female, to live alone, to be cognitively impaired, and to have depressive symptoms; were less likely to be non-Hispanic white; and had less education and more chronic conditions than did participants who were not physically frail.

Table 2 provides information on exposure to bed rest during the follow-up period. Approximately one half of the participants who were not physically frail had at least 1 episode of bed rest compared with two thirds of those who were physically frail. Among participants with at least 1 episode of bed rest, the mean number of months with bed rest were 3.2 (*SD* 2.9) and 2.4 (*SD* 1.9), respectively, for those with and without physical frailty ($p = .002$). Figure 1 provides descriptive information on the functional measures at baseline and 18 months. Compared with participants who were not physically frail, those who were physically frail had higher scores on the 2 measures of disability and lower scores on the 2 measures of ability at baseline and 18 months ($p < .001$ for each comparison).

Overall, among the 680 study participants, the number of months with bed rest was significantly associated with decline in each of the functional outcomes (Table 3). Significant associations were also observed for each of the outcomes among participants who were not physically frail but were observed only for IADL disability among those who were physically frail. To account for the occurrence of interval conditions that could confound the relation between bed rest and functional decline, we recomputed our models after adding a covariate for the number of new self-reported, physician-diagnosed chronic conditions, as determined during the 18-month follow-up assessment. The results of these supplementary analyses revealed only a slight diminution in the magnitude of the β coefficients and no substantive change in the probability values, other than for physical activity, in which the probability value changed from .035 to .116 for the overall results and from .029 to .065 for participants without physical frailty.

The mean disability scores at 18 months, adjusted for baseline disability and other covariates, are provided in Table 4 according to the number of months with bed rest. Overall and for participants who were not physically frail, the disability scores increased monotonically as the number of months with bed rest increased. For participants who were physically frail, the trends in disability scores were not monotonic and were statistically significant only for IADL disability. For the 2 measures of ability, the adjusted mean scores at 18 months tended to decrease as the number of months with bed rest increased (Table 5), although these trends were generally not monotonic. The strongest and most consistent association between bed rest and decline in ability was observed for social activity.

Discussion

In this prospective cohort study of community-living older persons, we found that episodes of bed rest were

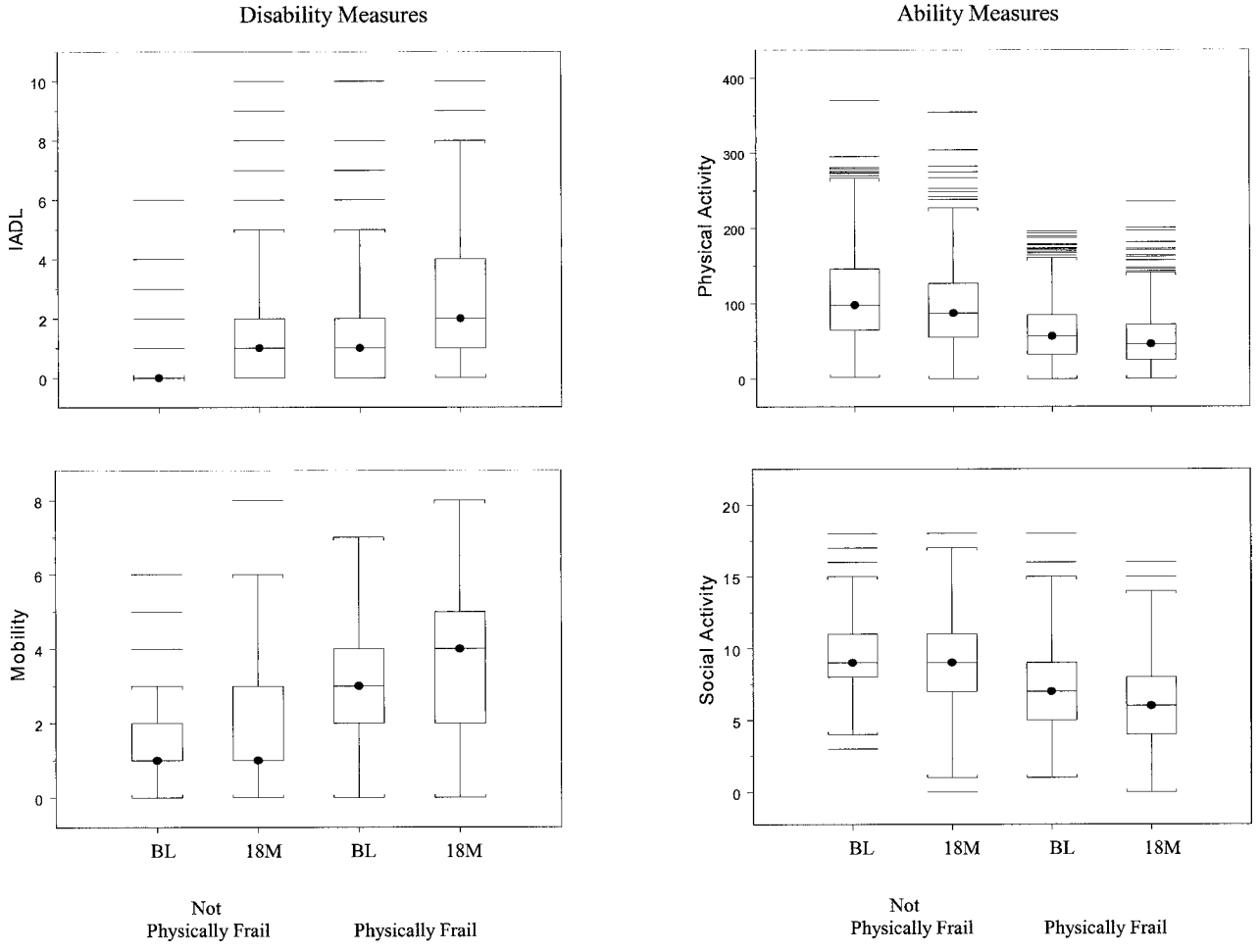

Figure 1. Box plots show scores for functional measures at baseline and 18 months by frailty group. The lower border, midline, and upper border of each box represent the 25th percentile, median, and 75th percentile scores, respectively. The lines from the boxes extend to the lowest scores no further than 1.5 box widths below the 25th percentile and to the highest scores no further than 1.5 box widths above the 75th percentile. The more extreme scores are represented by individual dashes. Low scores are good for the disability measures, whereas high scores are good for the ability measures. The median Instrumental Activities of Daily Living (IADL) score was 0 at baseline for participants who were not physically frail. BL = baseline assessment; 18M = 18-month assessment.

associated with decline in several important indicators of function, including IADLs, mobility, physical activity, and social activity. The deleterious effects of bed rest were observed despite adjustment for several potential confounders. Persons who were not physically frail appeared to be more susceptible to the adverse functional consequences of bed rest than were persons who were physically frail.

Table 3. Regression Coefficients for the Effects of Months With Bed Rest on Functional Outcomes*

	Overall			Physically Frail					
				No			Yes		
Functional Outcome†	β	*SE*	*p* Value	β	*SE*	*p* Value	β	*SE*	*p* Value
Disability Measure									
IADL	0.082	0.017	<.001	0.171	0.037	<.001	0.038	0.016	.015
Mobility	0.027	0.009	.003	0.077	0.018	<.001	0.013	0.011	.249
Ability Measure									
Physical activity	−0.088	0.042	.035	−0.141	0.064	.029	−0.049	0.056	.383
Social activity	−0.026	0.007	<.001	−0.036	0.010	<.001	−0.018	0.009	.062

Notes: *Results are adjusted for the baseline value of the respective functional outcome, age, sex, race/ethnicity, living situation, years of education, number of chronic conditions, physical frailty (for overall results only), cognitive impairment, depressive symptoms, and temperature (for physical activity only) as described in Methods.

†A positive β represents functional decline for the disability outcomes, while a negative β represents functional decline for the ability outcomes.

SE = standard error; IADL = instrumental activities of daily living.

Table 4. Mean Disability Scores at 18 Months According to the Number of Months With Bed Rest*

Number of Months With Bed Rest†	Overall	Physically Frail	
		No	Yes
IADL disability			
None	1.27	0.78	2.30
One	1.32	0.95	2.10
Two to three	1.62	1.21	2.43
Four or more	2.20	2.16	2.89
p Value for trend	<.001	<.001	<.044
Mobility disability			
None	2.15	1.44	3.54
One	2.34	1.69	3.52
Two to three	2.60	1.97	3.76
Four or more	2.73	2.20	4.10
p Value for trend	<.001	<.001	<.076

Notes: *Values represent the least square means, as calculated from the regression models, and are adjusted for the baseline value of the respective disability measure, age, sex, race/ethnicity, living situation, years of education, number of chronic conditions, physical frailty (for overall results only), cognitive impairment, and depressive symptoms as described in Methods.

†Higher scores represent greater disability for each of the outcomes.

IADL = instrumental activities of daily living.

Table 5. Mean Ability Scores at 18 Months According to the Number of Months With Bed Rest*

Number of Months With Bed Rest†	Overall	Physically Frail	
		No	Yes
Physical activity			
None	69.21	89.91	44.56
One	70.85	87.92	47.87
Two to three	64.08	79.26	45.08
Four or more	58.48	81.76	34.50
p Value for trend	.015	.063	.083
Social activity			
None	7.83	9.14	6.13
One	7.45	8.56	6.10
Two to three	7.10	7.91	6.15
Four or more	6.79	8.06	5.33
p Value for trend	<.001	.001	.085

Notes: *Values represent the least square means, as calculated from the regression models, and are adjusted for the baseline value of the respective ability measure, age, sex, race/ethnicity, living situation, years of education, number of chronic conditions, physical frailty (for overall results only), cognitive impairment, depressive symptoms and temperature (for physical activity only) as described in Methods.

†Higher scores represent greater ability for each of the outcomes.

Among hospitalized elderly persons, the adverse consequences of bed rest are well known (1–3); and early mobilization is a key component of successful interventions to prevent functional decline in the hospital (25,26). Bed rest among older persons is thought to contribute to a general deconditioning and an accelerated loss of muscle strength (2,5). Although the exact mechanisms have not yet been firmly established, these decrements in conditioning and muscle strength may lead to functional decline directly, or indirectly through a heightened susceptibility to falls and other debilitating conditions (27).

To our knowledge, no previous study has evaluated the association between bed rest and functional decline among community-living older persons. With few exceptions (28–30), previous studies of functional decline have focused exclusively on baseline risk factors (31) and, thus, have not considered the role of potential precipitating events, such as bed rest. This is problematic because the presence of baseline risk factors does not fully explain why older persons experience functional decline and disability. A sizable number of at-risk elderly persons, for example, do not experience functional decline, and many who do have few baseline risk factors (8,9,32–34).

In the current study, participants were asked each month whether they had stayed in bed for at least one half a day due to an illness, injury, or other problem. During the 18-month follow-up period, most participants had at least 1 month with bed rest and a substantial minority had several months with bed rest. Our ascertainment of bed rest had 2 important strengths. First, exposure was assessed monthly, with a completion rate of nearly 100%; and second, the reliability of these assessments was high. Because participants were not asked to specify the number of days that they had stayed in bed until later in the study, we could not rigorously evaluate the dose–response relation between bed rest and functional decline. Our finding that the scores on all 4 of the functional measures worsened during 18 months as the number of months with bed rest increased provides some evidence to support a dose–response relation. Although the absolute differences in these scores were modest, they are comparable to those that have been reported in the setting of recurrent and injurious falls (30), and they are likely to be clinically meaningful given the enormous costs and morbidity associated with functional decline among older persons (35–39).

Each episode of bed rest contributed equally to our exposure definition, regardless of duration. It is possible that the inclusion of very brief episodes may have diluted the magnitude of association between bed rest and functional decline. Based on data that we have subsequently collected, nearly one half (43%) the episodes of bed rest last only 1 or 2 days. As our follow-up data accrue, we will determine whether the relation between bed rest and functional decline is strengthened by the use of a more refined exposure definition.

It is not entirely clear why persons who were physically frail were less susceptible to the adverse functional consequences of bed rest than those who were not physically frail. One explanation may be that persons who were physically frail had higher rates of attrition. Of the original 322 participants who were physically frail, 8.7% died and 5% did not complete the 18-month follow-up assessment, as compared with 4.2% and 2.8% of participants who were not physically frail ($p = .009$). Because most deaths among older persons are preceded by functional decline and disability (40,41) and because decedents who were physically frail had rates of bed rest that were comparable to those reported in Table 2 despite a shorter length of follow-up (data not shown), the association between bed rest and functional decline may have been spuriously diminished among persons who were physically frail. A second explanation may be that persons who were physically frail had less opportunity to decline than did those who were not physically frail. Based

on the distribution of baseline scores (Figure 1), a floor effect would most likely have been operative for physical activity.

Important strengths of our study include the relatively low rate of attrition and the completeness of data collection, not only for the exposure variable but also for the outcome measures and covariates. Of course, as is true for any observational study, we cannot firmly establish a cause–effect relationship between bed rest and functional decline. Our multivariable models adjusted for the most relevant factors that may have confounded this relationship. The consistency of our findings across several different outcomes further supports a possible cause–effect relationship. Although our data do not allow us to distinguish the deleterious effects of bed rest from those of the underlying illness, injury, or other problem, our results changed little when new physician-diagnosed chronic conditions were included in the multivariable models as covariates.

In light of our findings, additional research is needed to identify the most common precipitants of bed rest among community-living older persons and to determine whether interventions to prevent or more aggressively treat these precipitants or to encourage alternatives to bed rest are effective in reducing functional decline and disability.

Acknowledgments

The authors thank Denise Shepard, BSN, MBA, Shirley Hannan, RN, Andrea Benjamin, BSN, Martha Oravetz, RN, Alice Kossack, Barbara Foster, Shari Lani, Alice Van Wie, and the late Bernice Hebert, RN, for assistance with data collection; Evelyne Gahbauer, MD, MPH, for data management and programming; Wanda Carr and Geraldine Hawthorne for assistance with data entry and management; Peter Charpentier, MPH, for development of the participant tracking system; and Joanne McGloin, MDiv, MBA, for leadership and advice as the Project Director.

Funded in part by grants from the National Institute on Aging (R01AG17560; K23AG00759), Robert Wood Johnson Foundation, Paul Beeson Physician Faculty Scholar in Aging Research Program, and Patrick and Catherine Weldon Donaghue Medical Research Foundation. Dr. Gill is the recipient of a Midcareer Investigator Award in Patient-Oriented Research (K24AG021507) from the National Institute on Aging.

Address correspondence to Thomas M. Gill, MD, Yale University School of Medicine, Dorothy Adler Geriatric Assessment Center, 20 York Street, New Haven, CT 06504. E-mail: gill@ynhh.org

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Received March 13, 2003
Accepted April 23, 2003