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ORIGINAL RESEARCH

Rates of Recovery to Pre-Fracture Function in Older Persons with Hip Fracture: an Observational Study

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BACKGROUND: Knowledge about expected recovery after hip fracture is essential to help patients and families set realistic expectations and plan for the future.

OBJECTIVES: To determine rates of functional recovery in older adults who sustained a hip fracture based on one's previous function.

DESIGN: Observational study.

PARTICIPANTS: We identified subjects who sustained a hip fracture while enrolled in the nationally representative Health and Retirement Study (HRS) using linked Medicare claims. HRS interviews subjects every 2 years. Using information from interviews collected during the interview preceding the fracture and the first interview 6 or more months after the fracture, we determined the proportion of subjects who returned to pre-fracture function.

MAIN MEASURES: Functional outcomes of interest were: (1) ADL dependency, (2) mobility, and (3) stair-climbing ability. We examined baseline characteristics associated with a return to: (1) ADL independence, (2) walking one block, and (3) climbing a flight of stairs.

KEY RESULTS: A total of 733 HRS subjects ≥65 years of age sustained a hip fracture (mean age 84 ± 7 years, 77 % female). Thirty-one percent returned to pre-fracture ADL function, 34 % to pre-fracture mobility function, and 41 % to pre-fracture climbing function. Among those who were ADL independent prior to fracture, 36 % returned to independence, 27 % survived but needed ADL assistance, and 37 % died. Return to ADL independence was less likely for those ≥85 years old (26 % vs. 44 %), with dementia (8 % vs. 39 %), and with a Charlson comorbidity score >2 (23 % vs. 44 %). Results were similar for those able to walk a block and for those able to climb a flight of stairs prior to fracture.

CONCLUSIONS: Recovery rates are low, even among those with higher levels of pre-fracture functional status, and are worse for patients who are older, cognitively impaired, and who have multiple comorbidities.

KEY WORDS: hip fracture; geriatrics; function; activities of daily living; palliative care.

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INTRODUCTION

Hip fracture is a public health problem worldwide with the annual incidence estimated to reach 2.6 million in the year 2025 and is associated with excessive mortality.[1] In 2010, 289,000 hospitalizations in the US were for hip fracture in older adults. The vast majority of older adults who sustain a hip fracture undergo surgical intervention with post-surgical care pathways focused on rehabilitating patients to their premorbid level of function. Rehabilitative efforts to return the older adult to their pre-fracture function have, therefore, been the predominant goal of research agendas and interventions over the past decades.[2–4]

While hip fracture management has been traditionally focused on curative and rehabilitation models of care in which the focus is on restoring patients to independent function, this model may not meet the needs of patients and families if the actual functional outcomes experienced by patients with hip fracture are less positive. Many patients with hip fracture are developing increasing levels of frailty and functional dependence even before the hip fracture, and the likelihood of returning to their previous level of function may be low in these patients.[5] Indeed, studies of hip fracture patients in the northeast region of the US have shown a 14–54 % rate of recovery.[6–8] However, few utilized population-based cohorts with access to pre-fracture functional status data. Identifying patients who are unlikely to return to their prior level of functioning may be useful in targeting patients in whom a supportive care approach, with anticipatory guidance, would complement the traditional rehabilitative care plan.

In order to determine the proportion of older adults who return to their prior level of function after sustaining a hip fracture, we compared and pre- and post-fracture function among those who sustained hip fracture while enrolled in the Health and Retirement Study (HRS). The HRS is a

cohort representative of the older US population. We first compared pre- and post-fracture function for activities of daily living (ADL), walking, and stair climbing and then assessed which baseline patient demographic and clinical factors predicted particularly low or high likelihood for recovery.

METHODS

Subjects

The HRS is a longitudinal study that measures changes in the health and economic circumstances of Americans as they age and is nationally representative of persons over the age of 50. It was initiated in 1992, with new subjects periodically recruited to remain representative of the US population. HRS interviews are conducted by phone or face to face (response rate >80 %) every 2 years. If an individual is unable to complete an interview because of physical or cognitive impairment, the interview is conducted with a proxy respondent, generally a family member.

We identified hip fracture cases in HRS subjects aged 65 and older by linking the HRS survey data to Medicare claims. We used Fisher's hip fracture algorithm to identify individuals with hip fracture.[9] An individual was identified as having a hip fracture if one of the following two conditions was met: (1) the individual was admitted to a hospital with an admitting diagnosis ICD-9 code for hip fracture "820.xx" or (2) a surgeon's charge for operative hip fracture repair (CPT code 27230–27248) supported with either (a) a second surgeon's charge within 2 days or (b) a supporting ICD-9 procedure code for hip fracture surgery (ICD-9 785.5, 790.5, 791.5, 792.5, 793.5).[9] We excluded admissions that were considered late effects from a prior hip fracture (ICD9 733.81, 733.82, 905.3, V540-V549) as done in previous studies.[9–11]

Out of 25,146 HRS subjects age 65 or older between 1992 and 2010, 19,006 (76 %) agreed to have their HRS surveys linked to the Medicare claims. We identified 1,124 hip fractures among those subjects. Since we used Medicare claims to identify comorbidities prior to the hip fracture event, we excluded hip fractures that were not preceded by one continuous year of Medicare fee-for-service enrollment. Of the remaining 1,017 hip fractures, 189 (19 %) subjects had no HRS interview within 2.5 years before or after the hip fracture event and were excluded. A 2.5 years' timeframe was used because of the uneven timing between the biennial interviews. Subjects that died within 2.5 years after hip fracture were included despite not having an HRS interview after the hip fracture event. Since considerable recovery still occurs during the 6 months after the hip fracture,[6] we excluded 94 interviews that occurred within this time frame. The resulting cohort included 733 HRS subjects with hip fracture.

Measures

The primary outcomes were functional recovery after hip fracture in (1) activities of daily living (ADLs), (2) mobility, and (3) stair climbing. ADLs are measured by the number of activities of daily living (i.e., bathing, dressing, eating, toileting, transferring) in which subjects needed assistance. Mobility is measured with three levels of difficulty: no difficulty with walking one block, difficulty walking one block but no difficulty walking across the room, or difficulty walking across the room. Stair climbing is measured as a dichotomous variable: no difficulty with climbing one flight of stairs without resting or difficulty climbing a flight of stairs without resting. Representative sample questions are included in Appendix 1.

For each outcome, we defined functional recovery as survival with a return to pre-hip fracture function, which we term as a subject's "baseline function." To determine the baseline function of each measure, we used the HRS interview obtained preceding the hip fracture, with a maximum window of 2.5 years (mean = 11.6 ± 7.4 months). The time frame of 2.5 years is to account for the slightly uneven spacing of interviews across interview waves. To assess post-fracture function, we used the first interview obtained between 6 months and 2.5 years after hip fracture (mean = 12.5 ± 8.1 months). Pre- and post-fracture function used function data provided by proxy respondents when the subjects could not be interviewed (20.9 %). Returning to baseline function was determined by comparing the pre- and post-fracture survey data and was treated as a dichotomous variable.

The HRS interview data were used to characterize the sample in terms of self-reported age, gender, race or ethnicity (e.g. non-Hispanic white, non-Hispanic black, Hispanic, and other), education, wealth, income, marital status, and nursing home residence. We determined a history of dementia and a Charlson comorbidity score for each subject using Medicare claims.[12] Dementia was evaluated independent of the Charlson comorbidity score a priori given previous studies suggesting poor outcomes in hip fracture patients with dementia.[13,14] We also used the Lee Index, a validated prognostic index for 4-year mortality in older adults where a score of 13 is associated with 59 % risk of death within 4 years.[15] Mortality after hip fracture was determined using National Death Index-linked data.

Statistical Analysis

First, we analyzed the outcomes for each baseline function stratum. We calculated the proportion of subjects who: (1) returned to their pre-fracture function, (2) survived but did not recover to their pre-fracture function, or (3) died, as described above.

Next, we calculated the probability of survival with return to a high level of function. We examined the probability of subjects who were ADL-independent returning to ADL independence, the probability of subjects who had no difficulty

walking a block returning to having no difficulty walking a block, and the probability of subjects who had no difficulty climbing a flight of stairs returning to having no difficulty climbing a flight of stairs. We used logistic regression models to estimate these probabilities across a variety of subgroups defined by clinical and demographic characteristics after adjusting for age and gender. For example, to compare the probability of recovery in subjects with and without dementia, we first fitted a logistic regression model in which the outcome was ADL independence and the predictor variables were dementia (yes/no), age, and gender. Then, using the same distribution of age and gender as in the overall sample, we used this model to calculate the probability of recovery when dementia was set to 1 (present) and when dementia was set to 0 (absent).

All analyses were weighted to account for the differential probability of subject selection and the complex design of the HRS. Statistical analyses were performed using Stata software, version 12 (StataCorp, College Station, TX) and SAS software, version 9.3 (SAS Institute, Cary, NC). The institutional review board at the University of California, San Francisco, approved this study.

RESULTS

Table 1 presents descriptive information of the 733 subjects with hip fracture. At the time of their hip fracture, the average age of the subjects was 84 ± 7.3 years. Most were female (77 %), almost half had a high comorbidity burden (Charlson >2, 44 %), 38 % had a Lee Index ≥13, and 17 % had a dementia diagnosis. Prior to the hip fracture event, 74 % were independent in their ADLs, 58 % had no difficulty walking one block, and 49 % had no difficulty climbing one flight of stairs without resting.

Rates of returning to baseline ADL, mobility, and climbing function following hip fracture are shown in Fig. 1. Of all subjects, 31 % returned to their prior ADL function, 34 % returned to their prior mobility function, and 41 % returned to their prior climbing ability. Even for subjects with the highest level of function at baseline, recovery rates were low at least 6 months after their hip fracture: 36 % were ADL independent, 32 % had no difficulty walking one block, and 29 % had no difficulty climbing one flight of stairs without resting. About one-third of the subjects with the highest level of function at baseline survived but sustained a functional decline after their hip fracture: 27 % with new ADL dependency, 33 % with new mobility difficulty, and 34 % with new difficulty stair climbing without resting.

Table 2 shows the probability of returning to function among persons who were in the highest level of baseline function for each measure, adjusting for age and gender. The factors that were consistently associated with low rates of functional recovery across all three measures were advanced age, dementia, and high comorbidity (Charlson score >2). Lastly, we found no association among race, marital status, wealth, and income prior to fracture with any of the outcomes. However, less than high school education was associated with a lower probability of returning to ADL independence and with being able to walk one block. In addition, male gender was associated with a lower probability of returning to ADL

Table 1 Baseline Characteristics of Subjects

Characteristics	Cohort	
	N* = 733	%
Age at hip fracture (mean ± SD)	84.0 ± 7.3	
Age at hip fracture		
65–74 years (n =)	96	12.8
75–84 years (n =)	273	39.0
85–89 years (n =)	213	29.5
≥90 years	152	18.7
Sex		
Male	177	23.2
Female	556	76.8
Race		
White	642	92.6
Black	50	3.7
Hispanic	37	3.3
Other	4	0.4
Education		
Greater than high school education	407	57.9
Less than high school education	326	42.1
Income [median (IQR)]	17K (9K–31K)	
Net worth [median (IQR)]	81K (8K–268K)	
Marital status		
Single or widowed	488	68.5
Married or partnered, %	244	31.5
Proxy interview		
No	581	79.1
Yes	153	20.9
Lee Index		
<13, %§	449	61.6
≥13, %§	284	38.4
Charlson Comorbidity Scale score		
≤2	413	55.9
>2	320	44.1
Nursing home residence, %		
No	658	9.5
Yes	75	10.5
Number of ADL dependencies †,‡		
0 ADL dependencies	539	74.0
1 ADL dependency	87	11.1
2 or more ADL dependencies	100	14.8
Mobility‡		
No difficulty walking one block	393	57.8
Difficulty walking one block with no difficulty walking across the room	148	20.8
Difficulty with walking across the room	151	21.4
Climbing‡		
No difficulty climbing one flight of stairs without stopping	326	48.7
Difficulty climbing one flight of stairs without stopping	368	51.3

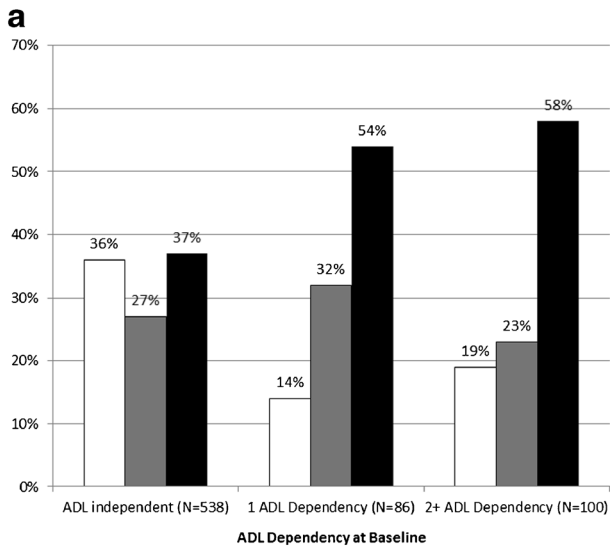
Reported values incorporate survey weights to account for the complex survey design. Proxy interview was used if subject was physically or cognitively unable to complete the interview

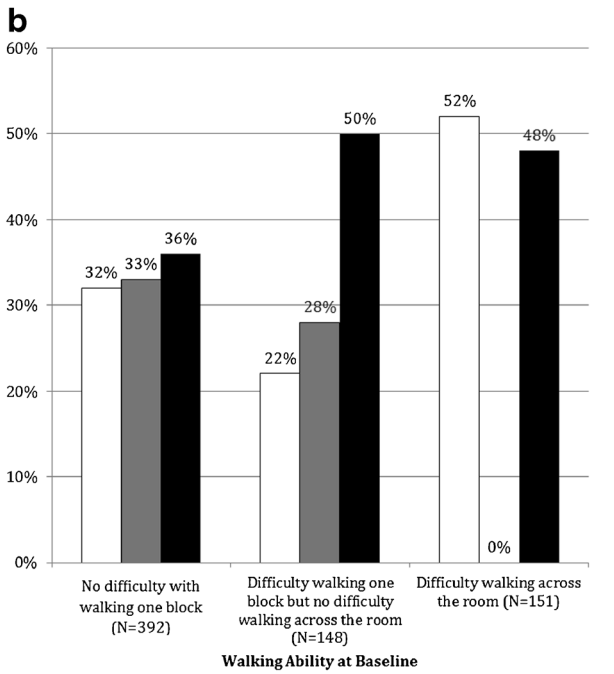
** some Ns may be unweighted*

†ADL dependency: needing assistance to complete the activity of daily living (ADL); ADL consists of bathing, dressing, eating, toileting, transferring

‡ Number of subjects missing data as follows: Number of ADL dependencies: 7, Mobility: 41, Climbing: 39

§ Lee Index ≥13 is associated with 59 % probability of 4 year mortality





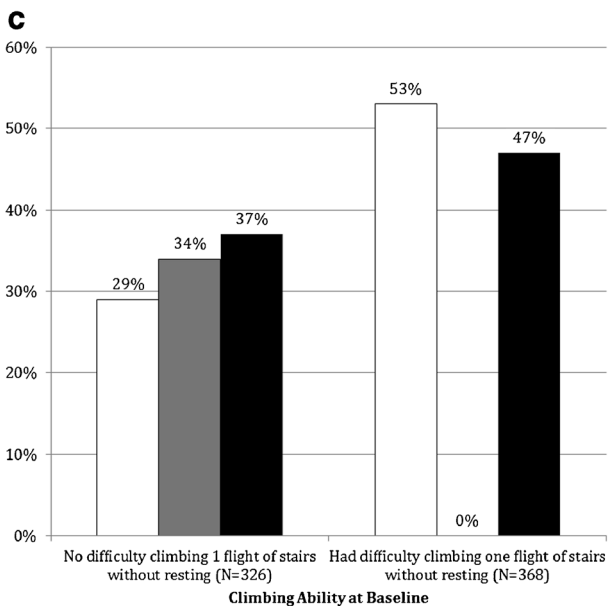


Fig. 1 Likelihood of returning to pre-hip fracture function in groups stratified by baseline function. This figure presents the proportion of HRS subjects with hip fracture returning to their prior ADL, mobility, and climbing function at the follow-up interview 6 months–2.5 years after the hip fracture (average, 12.5 ± 8.1 months), stratified by their baseline function. a Activities of daily living (ADL). b Walking. c Climbing. Footnote: Baseline function is determined by the pre-hip fracture interview most immediate to the hip fracture event. Returning to pre-hip fracture function was measured by comparing the function reported in the interview 6 months to 2.5 years after the hip fracture to their baseline function (mean 12.5 ± 8.1 months).

independence, and nursing home residency was associated with a lower probability of returning to being able to walk at least one block.

DISCUSSION

Functional recovery in older adults who sustained a hip fracture ranged from 31 to 41 % across our functional outcomes. We found that many older adults who sustained a hip fracture were dependent in ADL, limited in mobility, and limited in stair climbing even before the hip fracture event. Further, the likelihood of recovery to the pre-fracture level of function was less than 50 % regardless of one's previous level of function. Among those with a high baseline function (e.g., ADL independent, no difficulty with walking a block, or no difficulty climbing a flight of stairs without resting), approximately one-third returned to their prior level of functioning. The likelihood of returning to this high level of function was particularly low in those who were older than age 85, had multiple comorbid conditions, or had dementia.

This study has identified a group of older adults who have a low probability of recovery to their pre-fracture function. With the use of prospectively collected, pre-fracture functional data, this population-based study extends the findings of previous regional studies. In a regional study published in 1990 evaluating functional recovery after a hip fracture, 40 % returned to ADL independence and 54 % returned to walking independently post-hip fracture.[6] In a recent meta-analysis assessing function 1 year after hip fracture in older adults, 42 % did not return to their pre-fracture mobility, 35 % were unable to walk independently as a result of the fracture, and 14 % of older adults who sustained a hip fracture were no longer able to climb stairs.[16] Our findings suggest a distinctly lower recovery rate than these previous studies, further emphasizing that a large number of hip fracture patients will suffer long-term functional disability. As compared to prior studies, our study cohort was older, included those with dementia, had a greater prevalence of nursing home patients, and had self-reported pre-fracture functional status data.[17] Since our subjects were part of a population-based study, the greater risk of subjects in our study likely more accurately represents the advanced age and severe morbidity of patients who have hip fracture.

Rehabilitative care and a focus on returning to function have been traditional priorities of hip fracture care. However, our

Table 2 Proportion returning to baseline function among hip fracture subjects with high levels of baseline function. Adjusted for age and gender

	ADL independence (needs no help in any ADL) $N=539$ % (95 % CI)	*p*-value	Mobility (no difficulty walking one block) $N=394$ % (95 % CI)	*p*-value	Climbing (no difficulty climbing one flight of stairs) $N=326$ % (95 % CI)	*p*-value
Total population	35 (31–39)		30 (24–35)		28 (22–34)	
Age						
<85	44 (37–51)	0.002	41 (34–48)	<0.001	34 (25–43)	0.041
≥85	26 (20–32)		19 (12–25)		21 (14–29)	
Gender						
Male	27 (19–35)	0.038	21 (11–30)	0.07	20 (10–29)	0.077
Female	38 (33–43)		33 (26–40)		32 (24–39)	
Race/ethnicity						
White	35 (31–40)	0.476	30 (24–36)	0.490	29 (22–35)	0.174
Non-White	30 (18–43)		24 (7–40)		18 (6–30)	
Married						
No	36 (31–40)	0.584	31 (24–38)	0.614	25 (19–31)	0.124
Yes	33 (26–41)		28 (19–37)		33 (23–42)	
Nursing home						
No	–		31 (26–37)	0.041	29 (23–35)	0.175
Yes			7 (0–18)		8 (0–24)	
Dementia						
No	39 (34–44)	<0.001	34 (28–41)	<0.001	31 (25–38)	0.023
Yes	8 (2–15)		8 (1–14)		8 (0–17)	
Charlson Scale score						
≤2	44 (38–50)	<0.001	35 (27–43)	0.043	35 (27–42)	0.006
>2	23 (17–30)		22 (14–30)		18 (9–27)	
Education less than HS*						
No	39 (34–44)	0.019	33 (26–40)	0.015	29 (22–36)	0.602
Yes	29 (23–35)		23 (16–30)		26 (15–36)	
Income less than median						
No	36 (30–42)	0.611	30 (23–37)	0.866	30 (23–38)	0.225
Yes	34 (28–39)		29 (21–38)		24 (16–33)	
Wealth less than median						
No	39 (32–45)	0.111	33 (27–39)	0.117	32 (23–40)	0.138
Yes	30 (24–37)		25 (17–34)		22 (12–31)	

**HS: high school*

findings of low functional recovery rates, regardless of baseline function, emphasize the need to prepare patients and families with the realistic expectations that recovery may not occur. Furthermore, we determined that age, dementia, and comorbidity burden were associated with a lower likelihood of recovery across the spectrum of pre-fracture function. Our study supports the need for frank discussions with the patient and family about survival prognosis and likelihood of functional recovery. Ascertainment of the patient's values and goals of care, also termed "advance care planning," is critical at this juncture in order to optimize quality of life and assist in future medical decision making. In addition, comprehensive interdisciplinary supportive care particularly focused on psychosocial support and physical supportive home care is appropriate for a large proportion of patients.

Over the past decade, hip fracture co-management models have been developed, shown to improve patient care, and subsequently adopted by some hospitals.[18,19] In the co-management model, a geriatrician ensures appropriate medical treatments are undertaken and discusses prognosis; thus, patient and family members develop proper expectations of post-hip fracture recovery and needs. While this model has improved in-hospital post-fracture care, little is known about additional supportive needs by patients and families once the patient returns home. Additional research is needed to better understand the experiences, preferences, and needs of these patients and family members to successfully transition from skilled nursing facilities to home.

Our study design has several strengths. Two main strengths include: (1) the use of a population-based study to identify a representative sample of older adults with hip fracture and (2) the availability of functional status assessments before a hip fracture, thereby not subjected to recall bias. The interpretation of our findings must also take into account several limitations. First, we leveraged an ongoing study to collect data on physical function before and after hip fracture, and, as a result, pre-post functional assessments in both time periods occurred over a 2-year period. Our other work with the HRS hip fracture cohort subjects that persons with hip fracture may start declining in function 9 months before hip fracture.[5] Therefore, the definition of functional recovery we use in this study may encompass both the functional loss that happened after the fracture and the functional deterioration that led up to the hip fracture. In addition, the validity of using administrative codes for defining a history of dementia has been variable in the literature, though specificity tends to be high for those cases identified.[20] Also, the functional classification used in this study was patient self-reported and is not based on a validated

measurement; however, the questions asked reflect what might be asked in a clinical setting (Appendix 1). Lastly, it is possible some of the negative outcomes observed in our paper would have been mitigated by better quality of care, such as the type of care provided by orthogeriatrics units, which are more common in Europe than the US.[21]

In conclusion, we found that older adults who sustain a hip fracture have low rates of returning to pre-fracture function, regardless of their previous physical function. Also, for patients with a high level of pre-fracture function, the likelihood of functional recovery is higher among those without dementia and with a low comorbidity burden. Given the low likelihood of older adults returning to their previous levels of physical function, usual rehabilitation care models should consider integration of supportive care services to meet the needs of older adults and caregivers.

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Contributors: *The ten listed authors were the sole contributors to this manuscript. Dr. Tang was responsible for all aspects of the study; Drs. Sudore, Smith, Ritchie, Wallhagen, and Covinsky were involved in study design and critical revision of the manuscript; Drs. Finlayson and Petrillo were involved in the critical revision of the manuscript; Ms. Stijacic Cenzer and Dr. Boscardin were involved in the statistical study design, analysis, and critical revision of the manuscript. All authors had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.*

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Compliance with Ethical Standards:

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Conflict of Interest: *All authors declare no conflicts of interest.*

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APPENDIX 1: HEALTH AND RETIREMENT STUDY SAMPLE QUESTIONS

ADL: "Does anyone ever help you […]?" "dress," "bathe," "eat," "get in or out of bed," and "use the toilet."

Walking: "Because of a health problem do you have any difficulty with walking one block?"

Climbing: "Because of a health problem do you have any difficulty with climbing one flight of stairs without resting?"