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Life-Space Mobility Declines Associated with Incident Falls and Fractures

Alexander X. Lo, MD, PhD[a], **Cynthia J. Brown, MD, MSPH**[b,c,d], **Patricia Sawyer, PhD**[c,d], **Richard E. Kennedy, MD, PhD**[b,d], and **Richard M. Allman, MD**[e]

[a]Department of Emergency Medicine, University of Alabama at Birmingham, Birmingham, Alabama

[b]Birmingham/Atlanta VA Geriatric Research, Education, and Clinical Center, University of Alabama at Birmingham, Birmingham, Alabama

[c]Division of Gerontology, Geriatrics and Palliative Care, Department of Medicine, University of Alabama at Birmingham, Birmingham, Alabama

[d]Comprehensive Center for Healthy Aging, Birmingham, Alabama

[e]Geriatrics and Extended Care Services, Office of Patient Care Services, Veterans Health Administration, Washington, DC

Abstract

OBJECTIVES—To determine the impact of falls and fractures on life-space mobility in a cohort of community-dwelling older adults.

DESIGN—Prospective, observational study with a baseline in-home assessment and 6-month telephone follow-up interviews over 4 years.

SETTING—Central Alabama, U.S.A.

Corresponding Author: Alexander Lo, MD PhD: University of Alabama at Birmingham, Department of Emergency Medicine, 619 19th Street South, OHB-251, Birmingham, AL 35249. Telephone (205) 996-5579; fax (205) 996-9590. alexanderlo@uabmc.edu.
Alternate Corresponding Author: Patricia Sawyer, PhD: UAB Comprehensive Center for Healthy Aging, CH19-201, University of Alabama at Birmingham, 1720 2nd Avenue South, Birmingham, AL 35294-2041. Telephone (205) 934-9261; fax (205) 934-7354. patriciasawyer@uabmc.edu.

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PARTICIPANTS—Nine hundred seventy community-dwelling adults age ≥ 65 years, recruited from a random sample of Medicare beneficiaries were stratified by sex, race, and urban/rural residence.

MEASUREMENTS—Sociodemographic factors, medical history, depressive symptoms (using the Geriatric Depression Scale), cognitive function (using the Mini-Mental State Examination), mobility-related symptoms, transportation difficulty, and healthcare utilization were assessed during a baseline in-home interview of participants. Life-space mobility, as well as any falls or injuries (including fractures) were assessed both at the baseline interview and at six-month intervals by follow-up telephone calls.

RESULTS—Four hundred and fifty-four (47%) participants reported at least one fall during the 4-year follow-up. The life-space score decreased 3.2 points from the beginning to the end of the six-month interval during which a fall occurred, adjusting for other known predictors of decline in life-space mobility. The decrease in interval life-space score was progressively greater for a fall and an injury (−4.7 points), a fall and a fracture (−14.2 points), and was highest for a fall and a hip fracture (−23.6 points).

CONCLUSION—Falls, whether associated with an injury or not, were independently associated with a decrease in life-space mobility in the ensuing six months. Further studies are needed to determine reasons for life-space mobility decline among community-dwelling older adults with incident falls without any injuries.

Keywords

Falls; injury; mobility; life-space

INTRODUCTION

Falls occur in one third of community-dwelling adults ≥ 65 years old[1] and are associated with significant healthcare costs, morbidity, and mortality.[2–5] Over two million older persons present annually to the emergency department (ED) for falls, representing one in ten ED visits by older persons.[4] Falls-related healthcare utilization increased between 2001 and 2008[3] and accounted for $6.8 billion in total costs annually.[4] Falls cause 12% of deaths among older persons[2] and lead to loss of function and mobility.[5] Although the relationship between a fall and a subsequent mobility loss may be intuitive, clarification of this relationship using quantitative measures of mobility may identify persons at greatest risk of mobility loss after a fall.

The Life-Space Assessment (LSA) is a validated tool that measures mobility based on a person's life-space, defined as the space through which a person moves over a specified time period.[6,7] The LSA score is calculated using the person's life-space during the four weeks preceding the assessment, ranging from within one's dwelling to beyond one's town of residence, and incorporates where a person goes, the frequency of going there, and the use of equipment or help from another person. Life-space, as measured by the LSA, reflects community mobility, life-style and hence, social participation, as persons typically leave their homes for a specific purpose or destination.

Life-space was found to be associated with frailty,[8] mortality,[8,9] impairment in instrumental activities of daily living,[6,10] cognitive decline,[11] and nursing home admissions.[8,12] Loss of life-space may also have long-term effects, as life-space declines associated with non-surgical hospital admissions have been shown to persist up to two years after discharge.[13]

Improving our understanding of characteristics associated with life-space decline may help frame the question of how we might prevent loss of life-space. Defining declines in life-space associated with a fall, or an injury, or a fracture, may provide a method of evaluating the impact of community-based fall prevention programs or improve risk prediction in persons at risk for mobility decline. We are not aware of any published data on the impact of falls or injuries, in particular fractures, on life-space mobility. The aim of this study was to investigate the impact of falls and fractures on life-space mobility in community-dwelling older adults.

METHODS

Setting and Participants

The University of Alabama at Birmingham (UAB) Study of Aging was designed to understand subject-specific factors predisposing older adults to mobility decline as well as racial differences in mobility changes associated with aging. Participants were a stratified random sample of Medicare beneficiaries, age ≥ 65 years, living in five central Alabama counties.[7] Recruitment was set to achieve a balanced sample in terms of race, gender, and rural/urban residence. Persons were excluded if they lived outside of the five designated counties, were under the age of 65, or were unable to communicate on the telephone to make arrangements for in-home assessments.

Baseline in-home interviews were conducted between November 1999 and February 2001 after obtaining informed consent. An initial training session involved 10 interviewers prior to baseline to assure inter-rater reliability in administering the assessments. Subsequent interviewers were trained individually upon joining the team. In all, there were 21 trained interviewers. Test-retest reliability of the LSA, based on analysis of the first 300 assessments, demonstrated an intra class correlation coefficient (and 95% confidence interval) of 0.96 (0.95–0.97).[6]

Telephone follow-up interviews at each 6-month period over four years of follow-up assessed life-space and any self-reported falls, injuries or fractures that occurred at any time in the preceding 6 months. These were completed by two interviewers with the majority being completed by a single interviewer. If participants were unable to complete follow-up assessments, designated contact persons were interviewed. The UAB Institutional Review Board approved the study protocol. Details of the study methods have been described elsewhere.[7]

The current analysis used data from participants who had at least one 6-month follow-up interview in the four years after the baseline interview. Persons were censored at time of a nursing home admission or death so that results would be relevant to community-dwelling older adults.

Study Variables

Life-Space—Life-space was measured using the structured questions of the LSA: "During the past 4 weeks, have you: 1) been to other rooms in your home besides the room where you sleep; 2) been to an area outside your home such as your porch, deck, or patio, hallway of an apartment building, or garage; 3) been to places in your neighborhood other than your own yard or apartment building; 4) been to places outside your neighborhood, but within your town; and 5) been to places outside your town?" Participants were asked how frequently they attained that level and whether they used any assistive device or help from another person. A composite score ranging from 0 to 120 was calculated based on life-space level, degree of independence in achieving each level, and the frequency of attaining each level, with higher scores representing greater mobility.

The LSA is sensitive to change in life-space over time; only 2% of persons did not show an increase in life-space, while only 1% was unable to show a decline. Although persons may differ on how they define distances between specific life-space levels, these definitions are consistent over time for the individual.[10] Six-month changes in the life-space score were assessed by comparing scores for every 6-month interval assessed from baseline to the 48-month interview. Participants who were alive and had no missing 6-month assessments could contributed up to eight six-month life-space change scores to this analysis.

Falls, injuries or fractures—During each 6-month telephone interview, participants were asked if they had experienced any of the following events in the 6 months since the time of the last interview: (1) fall, (2) injury, (3) any fracture. Although a study participant may have reported having had, for example, a fall, an ankle injury and a wrist fracture, they were not asked if the injury or fracture occurred as a result of that fall.

Sociodemographic factors—Age, gender, race, education, income, and marital status were self-reported and collected only at the baseline interview.

Comorbidity count—At baseline, a verified comorbidity count was created giving one point for each disease category of the Charlson Comorbidity Index,[14] without consideration of severity. Comorbidities were considered verified if the participant reported the condition and took a medication for the condition, if the condition was reported on a questionnaire sent to the participant's physician, or if the condition was noted on a hospital discharge summary.

Mobility-related symptoms—Dizziness, fainting, pain, incontinence, shortness of breath, feeling tired or fatigued, feeling sleepy, stiffness and weakness in the legs were self-reported at the baseline in-home interview. A cumulative count of these mobility-related symptoms was used in the models.

Depression or depressive symptoms—Participants were assessed at the baseline interview using the 15-item version[15] of the Geriatric Depression Scale (GDS).[16]

Cognitive function—Cognitive function was measured at baseline using the Mini-Mental State Examination (MMSE)[17] score.

Transportation difficulty—Persons were defined as having transportation difficulty if they responded positively to either question: "Over the past four weeks, have you had any difficulty getting transportation to where you want to go?", and "Do you limit your activities because you don't have transportation?"

Emergency department (ED) utilization—Use of the ED in the preceding twelve months, was determined by self-report at the baseline interview.

Statistical Analysis

Bivariate analyses (chi-square and t-tests) were used to compare the characteristics of participants who reported a fall and those who did not. The association of falls and fractures with life-space was examined using six-month life-space change, defined as the difference in life-space scores based on the LSA before and after the interval in which a fall, injury or fracture occurred. The 970 participants with at least one six-month follow-up interval contributed 6,629 six-month life-space change scores. The statistical significance and independence of these associations were examined by adjusting for the baseline sociodemographic and clinical characteristics of the participants. Multivariable linear regression was used to examine the significance and independent association of life-space change scores with falls, injury, fractures, and hip fracture controlling for socio-demographic factors and co-morbidity as measured at baseline. Repeated measures analysis was used to account for correlation of observations among subjects. All statistical analyses were conducted using IBM SPSS statistics software version 21 (IBM Corporation, Somers, NY).

RESULTS

Among the 970 persons in the final study sample, 454 (47%) reported at least one fall. Of these 454 persons, 171 reported one or more falls and at least one injury of any type during the follow-up period, although the fall and the injury may not have been temporally related. Among these 171 persons, 58 had reported a fracture and 9 reported the fracture as a hip fracture. Participants who fell at any time during the study ("fallers") were, at baseline, older, more likely to be female, and less likely to be married (Table 1). They were also less likely to be African American, although this finding was not statistically significant (p=0.06). No significant differences in proportion of baseline level of income or baseline level of education were observed. Fallers had, at baseline, a lower life-space score, a higher number of comorbidities, and were more likely to report baseline mobility-related or depressive symptoms. There was a trend towards lower baseline cognitive function among fallers; although the MMSE score difference was not statistically significant (Table 2). Additionally, fallers were more likely to have presented to an ED in the twelvemonths prior to the baseline interview.

There was a decrease in life-space score of 3.2 points at the end of the 6-month interval in which there was a fall without any injury or fracture, even after adjusting for other known predictors of life-space mobility decline. Decline in interval life-space score was progressively greater for a combination of a fall and any injury (−4.7 points), a fall and any fracture (−14.2 points), and was highest for a fall and a hip fracture (−23.6 points).

DISCUSSION

Any fall was independently associated with a decrease in life-space mobility in the following six months. Increasingly severe injuries occurring in the same interval as the fall were associated with greater declines. In this population of community-dwelling older adults, falls were associated with several previously reported factors, including older age, being married, reporting a higher number of comorbidities, endorsing depressive symptoms, and reporting more mobility-related symptoms.[18,19]

These data reflect the combination of separate insults such as a fall and a hip fracture, even though they were temporally unrelated. Despite our inability to establish a causal link between the fall and the injury, our results show that either an isolated single fall or an unrelated injury can, by itself, produce a net loss of life-space. In situations where there is a combination of a fall and any type of injury within the same 6-month period, we observed a cumulative negative effect to life-space with separate contributions by each event. The finding that any fall was independently associated with a decline in life-space, even when no other injury was reported in the same 6-month period, suggests that even non-injurious falls can produce a deleterious impact on community mobility that persists for up to six months after the fall. Our results offer further evidence in support of the notion that falls have a negative impact on older adults, adding to previous studies that have found falls to result in functional decline, fear of falling, increased healthcare utilization and increased mortality.[5,18,20,21]

A possible underlying mechanism is that each individual event, whether a fall or a fracture, was associated with a potentially irreversible loss of mobility. Brown found that older patients with medical or surgical hospital admissions had a downward trajectory in life-space and those with medical reasons for hospitalization had a permanent net loss of life-space from baseline.[13]

Limitations of this study include the fact that life-space and falls were determined by self-report. The components of the assessment of life-space, including the frequency of attaining each level of participation, were self-reported, and there were no other sources (e.g. activity diary, family member) to formally validate self-reports. Falls were also self-reported at baseline and at each follow-up period and may be under-reported due to poor recall. Another limitation is that injuries and fractures reported within the same period as the fall may not be causally related to the fall. Other precipitating events, such as a motor vehicle collision resulting in a hip fracture, were not distinguished from a fall-related hip fracture. In our analysis, we limited changes in life-space to that six-month interval period in which the fall or fracture occurred, therefore the longer-term effect on life-space beyond six months following the fall or fracture is not described. The clinical implications of similar magnitude declines in life-space score are clearly different for those persons with unrestricted life-space who travels out of town regularly compared with those limited to their home.[22] For example, a person with unrestricted life-space at baseline who experiences a ten-point decline may still be able to travel out of the neighborhood without assistance from another person. A similar decline could cause a person who rarely went beyond their neighborhood without assistance to become homebound. Nevertheless, life-space scores have been demonstrated to predict death and nursing home admissions along the full continuum of mobility observed among community dwelling older adults.[12,23] In univariate and multivariate analyses on the association between the study variables (Tables 1 and 2) and incident falls, data on these covariates were collected only at baseline while the incident fall might have occurred at any time during the follow-up period, up to four years after baseline. It is reasonable to expect that some of the baseline characteristics (e.g., marital status, depressive symptoms, and transportation difficulties) may have changed over time, and ED utilization reported at baseline does not necessarily reflect the pattern of healthcare utilization throughout the entire follow-up period. Furthermore, the temporal gap between these characteristics and the outcome (incident fall) may weaken the hypothesis of a causal relationship.

These results highlight the adverse effect of falls on community mobility and raise the possibility that early intervention for non-injurious falls may have potential benefit in preserving mobility. Several fall intervention programs have been evaluated, including with randomized clinical trials, examining falls with and without injury, with mixed conclusions.[24–27] A recently updated expert panel on fall prevention guidelines highlighted interventions and assessments recommended for fallers and non-fallers with unsteady gait and balance.[28] Further research is needed to clarify the mechanisms by which a fall can cause a decline in community mobility, and determine whether the decline in mobility is due to a simple physical impairment or an indicator of a more complex physiological deterioration that puts the person at risk for further functional decline. Investigations of non-clinical potential predictors of loss of function and mobility related to falls, such as socioeconomic or neighborhood characteristics,[29] may yield additional avenues for fall prevention by identifying persons with a higher risk for mobility loss without substantial recovery.

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Table 1

Comparison of Patients with and without Incident Falls by Sociodemographic Characteristics.

Characteristic	Persons with Incident Falls (N=454)	Persons without Any Falls (N=516)	*P*-Value[a]
Age, mean (±SD)	76.2 (7.1)	74.3 (6.2)	<0.001
Female	57%	45%	<0.001
African American	47%	53%	0.06
Rural residence	52%	50%	0.58
Married	47%	55%	0.02
Income <$8,000 per year	25%	23%	0.45
Education < 7th grade	20%	21%	0.33

[a]Statistical comparisons involved t-test for comparison of means and chi square test for comparison of proportions.

Table 2

Comparison of Patients with and without Incident Falls by Clinical Characteristics

Characteristics	Persons with Incident Falls (N=454)	Persons without Any Falls (N=516)	*P*-Value[e]
Life-Space score[a] at baseline	59	69	<0.001
Comorbidity count	2.5	2.0	<0.001
Mobility-related symptoms[b], mean	4.2	2.9	<0.001
MMSE[c] score, mean	24.9	25.3	0.14
Depressive symptoms[d]	2.8	1.9	<0.001
Emergency Department (ED) use in the 12 months before baseline interview	32%	22%	0.001

[a]Life-Space score was determined by Life-Space Assessment (LSA) with scores ranging from 0 to 120 with higher scores representing greater community mobility.

[b]Mobility-related symptoms include dizziness, fainting, pain, incontinence, shortness of breath, tired or fatigue, sleepy, stiffness and weakness in legs.

[c]Mini-Mental State Examination

[d]Depressive symptoms were based on the 15-item short form of the Geriatric Depression Scale (GDS). Counts were out of a total of 15.

[e]Statistical comparisons involved t-test for comparison of means and chi square test for comparison of proportions.

Note: Data on baseline life-space score, comorbidity count, mobility-related symptoms, MMSE score, depressive symptoms and ED use were collected only at baseline. Incident falls were collected at each follow-up, throughout the entire follow-up period, which may range from 6 to 48 months.

Table 3

Crude and Multivariate-Adjusted Changes in Life-Space Mobility Scores Associated with Incident Falls or Injuries

Event (No. intervals[a])	Change in Life-Space Score	
	Crude	Adjusted[b]
No falls (5,744)	−1.2	N/A
All falls (885)	−3.2	−3.6
Any injury including fractures (222)	−6.1	−4.7
Any type of fracture (58)	−14.1	−14.2
Hip fracture (9)	−20.6	−23.6

[a]The number of intervals refers to the sum of the number of 6-month follow-up assessments completed for each person meeting criteria for the event in question.

[b]Multivariate linear regression models incorporating repeated measures were used to yield adjusted life-space score change. These models adjusted for life-space and age at the beginning of the interval, gender, race, rural/urban residence, married, transportation difficulty, comorbidity score, symptoms, MMSE and GDS; adjusted life-space change was significant for falls, injurious falls, falls with any fracture, falls with hip fracture with $p<0.001$ for all.