Research Report

Assessing Mobility in Older Adults: The UAB Study of Aging Life-Space Assessment

Background and Purpose. The University of Alabama at Birmingham (UAB) Study of Aging Life-Space Assessment (LSA) is a relatively new instrument to measure mobility. The purpose of this report is to describe the relationships between LSA and traditional measures of physical function, sociodemographic characteristics, depression, and cognitive status. **Subjects.** Subjects were a stratified random sample of 998 Medicare beneficiaries aged ≥65 years. The sample was 50% African American, 50% male, and 50% from rural (versus urban) counties. **Methods.** In-home interviews were conducted. Mobility was measured using the LSA, which documents where and how often subjects travel and any assistance needed during the 4 weeks prior to the assessment. Basic activities of daily living (ADL) and instrumental activities of daily living (IADL), cognitive status, income level, presence of depressive symptoms, and transportation resources were determined. The Short Physical Performance Battery (SPPB) was used to assess physical performance. **Results.** Simple bivariate correlations indicated a significant relationship between LSA and all variables except residence (rural versus urban). In a regression model, physical function (ADL, IADL) and physical performance (SPPB) accounted for 45.5% of the variance in LSA scores. An additional 12.7% of the variance was explained by sociodemographic variables, and less than 1% was explained by cognition and depressive symptoms. **Discussion and Conclusion.** The LSA can be used to document patients' mobility within their home and community. The LSA scores are associated with a person's physical capacity and other factors that may limit mobility. These scores can be used in combination with other tests and measures to generate clinical hypotheses to explain mobility deficits and to plan appropriate interventions to address these deficits. [Peel C, Sawyer Baker P, Roth DL, et al. Assessing mobility in older adults: the UAB Study of Aging Life-Space Assessment. *Phys Ther.* 2005;85:1008–1019.]

Key Words: *Geriatrics; Measurement, applied.*

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Assessing *mobility*, which we define as where people move or travel, taking into account the frequency of movement and degree of independence during such movement, is an essential task performed by physical therapists because most physical therapy interventions are intended to directly or indirectly improve mobility. Current measures of mobility include assessments of transfer skills, gait, or wheelchair mobility.[1–3] Basic activities of daily living (ADL) and instrumental activities of daily living (IADL) also are used by physical therapists to assess mobility.[4,5] Most of these assessments describe what people are able to do at a given point in time, rather than what people actually do in their daily lives. There is a need for an instrument that captures the broad spectrum of mobility experienced by community-dwelling people, providing an assessment of the frequency of travel to various locations and the need for assistance. Such an instrument would allow therapists to identify barriers to mobility within a person's home, neighborhood, and beyond.

The University of Alabama at Birmingham (UAB) Study of Aging Life-Space Assessment (LSA), a new instrument to evaluate mobility, measures a person's usual pattern of mobility during the month preceding the assessment.[6,7] Mobility, in terms of life-space, can be visualized as a pattern of areas defined by distance extending from the location where a person sleeps (Fig. 1). The LSA permits assessment of the full range of mobility, ranging from mobility dependent on assistance from another person and limited to the room where a person sleeps to daily, independent travel out of the person's town. The LSA documents mobility based on how far and how often a person travels to each of the defined levels and any assistance needed to get to each level. Using the instrument can show reductions over time in the frequency of travel or adaptations through the use of assistance, which are reflected in the overall score. Thus, therapists can use the instrument to determine baseline levels of mobility and to track changes that occur with interventions. Knowledge of the relationship between LSA scores and factors such as physical function, cognition, depression, and sociodemographic characteristics will assist therapists in the interpretation and use of LSA scores.

May et al[8] introduced the first measurement of life-space, the Life-Space Diary, in 1985. For the Life-Space Diary, life-space was divided into 5 concentric zones: the bedroom; the rest of the dwelling; the garden, courtyard, or grounds surrounding the dwelling; the "block" in which the dwelling is located; and the area across a traffic-bearing street.[8] Every day for 1 month, subjects

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Dr Peel, Dr Sawyer Baker, Dr Brown, and Dr Allman provided concept/idea/research design and writing. Dr Sawyer Baker provided data collection, project management, and subjects. Dr Roth and Mr Bodner provided data analysis. Dr Allman provided fund procurement. Dr Peel, Dr Sawyer Baker, Dr Roth, Dr Brown, and Dr Allman provided consultation (including review of manuscript before submission).

The study was approved by the University of Alabama at Birmingham Institutional Review Board.

This research was given as a platform presentation at the Combined Sections Meeting of the American Physical Therapy Association; February 4–8, 2004; Nashville, Tenn.

This research was funded by a grant to Dr Allman from the National Institute on Aging (Grant NIA AG15062, "Mobility Among Older African Americans and Whites").

This article was received December 30, 2003, and was accepted March 18, 2005.

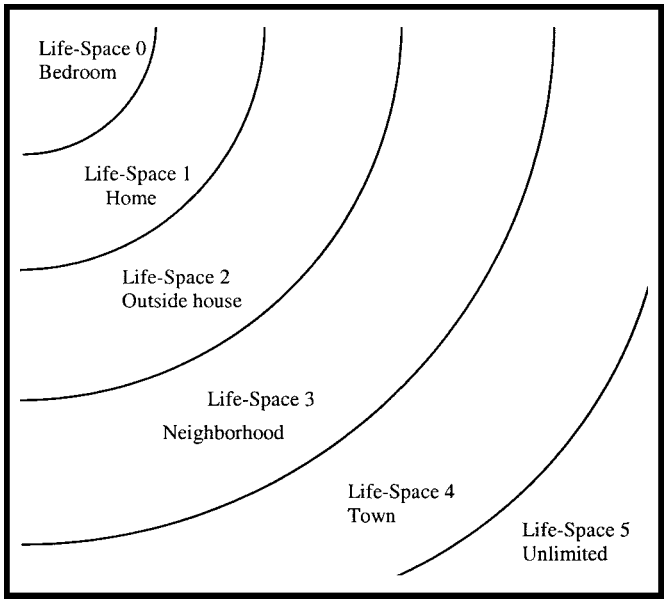

Figure 1.
Conceptual model showing life-space levels as a series of concentric areas radiating from the room where a person sleeps.

recorded the zones in which they moved during the day. Measurements of mobility obtained using the diary correlated directly with measurements of gait speed ($r=.79$) and inversely with mean sway path measurements ($r=-.65$).[8] One value of the diary was that it represented what subjects actually did rather than what they were capable of doing.[8] In 1990, Tinetti and Ginter[9] introduced the Nursing Home Life-Space Diameter (NHLSD), an adaptation of the Life-Space Diary to the nursing home setting. Life-space in the nursing home was divided into the following zones: the resident's room, outside the room but within the unit, outside the unit but within the facility, and outside the facility. Staff members rated residents on how often they moved within each of the zones over a 2-week period. Using subjects from 12 skilled nursing facilities (n=398), NHLSD scores were moderately associated with basic ADL scores ($r=.46–.53$) and with data on the frequency of participation in social activities ($r=.57$).[9] Potential uses of the NHLSD include assessing the effects of interventions on mobility and monitoring changes over time.[9]

Stalvey et al[10] introduced the Life-Space Questionnaire (LSQ) in 1999. This questionnaire was designed to capture a broader range of environmental regions characteristic of community-dwelling older adults. The LSQ consists of 9 questions that ask whether respondents have been to certain regions within their environment within the past 3 days. The regions range from the rooms within their home to travel out of the region of the United States in which they reside. Respondents answered either "yes" or "no" to each of the 9 questions. Scores on the questionnaire range from 0 to 9, with 1 point awarded for each "yes" answer. Although the authors reported a significant relationship between LSQ scores and measurements of physical performance and ADL, they reported a substantial amount of unshared variance (69%), indicating that the LSQ and performance measures are not redundant.[10]

The UAB Study of Aging LSA is similar to the assessment introduced by May et al[8] in that it evaluates mobility during the month before the assessment, but it is different in that it involves a single interview rather than requiring a subject to record activities in a diary. The 1-month assessment period was chosen to minimize the impact that transient illness or short-term changes in environmental or other factors would have on the assessment. Thus, the LSA provides a single number that reflects the lifestyle of the person in the 4 weeks prior to the assessment.

The LSA was designed to fill a void in the assessment of mobility in community-dwelling older adults. The life-space concept recognizes that, in addition to the domains of ambulation and physical functioning, mobility can be affected by other factors such as cognitive function and environmental factors.[11–13] Although many functional and physical performance assessments determine what patients are able to do,[1–4] the LSA reveals what patients actually do and whether assistance is needed. Declines in life-space should prompt clinicians to look for underlying causes for such changes that may be amenable to interventions. In addition, the LSA score may be a valuable outcome measure for interventions designed to enhance mobility.

Baker et al[6] introduced the LSA in 2003. In their report, the test-retest reliability of the LSA data was established (intraclass correlation coefficient=.96) by comparing baseline measurements obtained in an in-home interview with measurements obtained 2 weeks later via telephone interview. In their study, the LSA was repeated by telephone at 6 months, and the measurements were found to change by at least 10 points in 50% of the subjects. Changes in self-reported difficulty in ADL and IADL were less common.

Baker et al[6] described several ways to score the LSA. For example, the LSA can be scored to reflect simple measures of life-space that take into account only where the person went and whether or not any assistance was required.[6] Thus, "independent life-space" reflects the highest life-space level traveled where people go without any assistance from equipment or another person. "Life-space with equipment" reflects the maximum life-space level achieved with equipment but without help from another person, while "maximum life-space" reflects the maximum level achieved without considering the need

for help from equipment or another person. Another way to categorize life-space is "restricted," defined as confined to neighborhood, or "unrestricted," defined as able to travel to town independently. These simple measures of life-space do not show a normal distribution among community-dwelling older adults.[6] However, the composite scoring method that takes into account where a person went, the frequency of going, and the need for assistance yields scores ranging from 0 to 120, and the scores are normally distributed in this population.[6] Data obtained with the composite scoring method generally showed higher bivariate correlations with data for physical performance, the physical component scale of the Medical Outcomes Study 12-Item Short-Form Health Survey (SF-12), the Geriatric Depression Scale, and self-reported health than did the simple measures.[6] This article expands on the initial descriptive work of Baker et al[6] using multivariate modeling to understand the independent contribution of factors related to life-space mobility in a much larger sample of community-dwelling older adults.

The purpose of our study was to: (1) describe the relationships between LSA scores and measurements of daily function (ADL, IADL), physical performance, cognitive status, depressive symptoms, and sociodemographic variables (age, race, sex, income, availability of transportation, urban versus rural residence) and (2) determine the relative strength of groups of variables and of individual variables in a model to describe life-space. We used a multiple regression model involving sequential entry of the following 4 groups of variables: (1) physical function (ADL, IADL), (2) physical performance (Short Physical Performance Battery [SPPB]), (3) sociodemographic variables, and (4) cognition and depression. We followed this analysis with a test of the unique contribution of each variable. Knowledge of these relationships is essential for physical therapists to interpret LSA scores, to use these scores to develop clinical hypotheses regarding factors that influence the mobility of their patients, and to plan and evaluate care plans to address contributing factors.

Method

Subjects

The subjects were 1,000 participants in the UAB Study of Aging, a population-based, longitudinal study of mobility among community-dwelling older adults. Subjects were recruited from a stratified random sample of Medicare beneficiaries aged 65 years or older living in 5 counties of central Alabama. Two counties were classified as urban, and 3 counties were classified as rural.[14] This study oversampled African Americans, men, and rural residents to provide a balanced sample in terms of race, sex, and urban-rural residence.

Potential subjects were identified and contacted first by mail to solicit their participation in the study. Approximately 2 weeks after receiving the letter, subjects were contacted by telephone to determine their interest in participation. People in nursing homes and people who were unable to set their own appointments were excluded. For interested subjects, an in-home interview was scheduled. Prior to the interview, written informed consent was obtained.

In-home interviews were conducted by trained interviewers. The in-home interview, which lasted approximately 2 hours, included a detailed medical history, sociodemographic factors (eg, income, transportation difficulty), the Geriatric Depression Scale (GDS), the Mini-Mental State Examination (MMSE), LSA, ADL, IADL, and 3 measurements of physical performance (timed walk, timed chair stands, and standing balance). Participants were allowed to have proxy assistance to answer factual questions, but not questions related to perceptions of their depressive symptoms and so on. A proxy provided such assistance to 13.8% of the subjects.

Measurements

Life-space. The UAB LSA was used to identify the distance through which a person reported moving during the 4 weeks prior to the assessment. The life-space zones ranged from a person's bedroom to beyond the person's town (Fig. 1). Specific questions were: (1) "During the past 4 weeks, have you been to other rooms of your home besides the room where you sleep (level 1)?" (2) "During the past 4 weeks, have you been to an area immediately outside your home such as your porch, deck, or patio; hallway of an apartment building; or garage (level 2)?" (3) "During the past 4 weeks, have you been to places in your immediate neighborhood, but beyond your own property or apartment building (level 3)?" (4) "During the past 4 weeks, have you been to places outside your immediate neighborhood but within your town (level 4)?" and (5) "During the past 4 weeks, have you been to places outside your immediate town (level 5)?" For each life-space level, subjects were asked how often they traveled to that area (less than once a week, 1–3 times each week, 4–6 times each week, daily) and whether they needed assistance from another person or from an assistive device ("yes" versus "no"). An example of a completed form is shown in Figure 2.

The LSA was scored by assigning a value to each of the 5 levels and then summing the 5 scores. The level scores were obtained by multiplying the level number (1–5) by a value for independence (2="no assistance," 1.5="use of equipment only," 1="use of another person and/or equipment") times a value for frequency of movement (1=less than once a week, 2=1–3 times each week,

Name: | Date:

These questions refer to your activities just within the past month.

LIFE-SPACE LEVEL			FREQUENCY				INDEPENDENCE	SCORE
During the past four weeks, have you been to . . .			**How often did you get there?**				**Did you use aids or equipment? Did you need help from another person?**	Level X Frequency X Independence
Life-Space Level 1. . . **Other rooms of your home besides the room where you sleep?**	Yes 1	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	1	X	4		X	1.5	=	6 *Level 1 Score*
Life-Space Level 2. . . **An area outside your home such as your porch, deck or patio, hallway (of an apartment building) or garage, in your own yard or driveway?**	Yes 2	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	2	X	4		X	1.5	=	12 *Level 2 Score*
Life-Space Level 3. . . **Places in your neighborhood, other than your own yard or apartment building?**	Yes 3	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	3	X	2		X	1.5	=	9 *Level 3 Score*
Life-Space Level 4. . . **Places outside your neighborhood, but within your town?**	Yes 4	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	4	X	2		X	1	=	8 *Level 4 Score*
Life-Space Level 5. . . **Places outside your town?**	Yes 5	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	0	X			X		=	0 *Level 5 Score*
							TOTAL SCORE (ADD)	35 *Sum of Levels*

Figure 2.
Example of scoring of the Life-Space Assessment. The subject traveled to all levels (levels 1–4) except for out of town (level 5); traveled daily to levels 1 and 2, and traveled 1 to 3 times each week to levels 3 and 4; uses a cane at all times and requires assistance with driving.

3=4–6 times each week, and 4=daily) (Fig. 2). The LSA scores ranged from 0 ("totally bed-bound") to 120 ("traveled out of town every day without assistance"). The test-retest reliability of data for the LSA has been established (intraclass correlation coefficient=.96).[6]

ADL/IADL. Both ADL and IADL were measured by self-report.[15] The 5 ADL items were eating, using the toilet, dressing, transferring, and bathing. The 6 IADL items were using the telephone, managing money, preparing meals, doing light housework, shopping, and doing heavy housework. For each item, subjects were asked: "Do you have any difficulty performing the task?" If subjects answered "no," a score of 0 was assigned. If subjects answered "yes," they were asked to rate, using a Likert-type scale, the level of difficulty for the task. Responses were scored as: 1="some," 2="a lot," or 3="unable to do the task." Subjects also could answer that they "did not perform the task for other reasons," an answer that was coded as a missing value (Fig. 3). The numbers of subjects with missing values for the individual tasks were: using the telephone (n=1), transferring (n=1), light housework (n=25), managing money (n=28), preparing meals (n=41), shopping (n=52), and heavy housework (n=72). For statistical analyses, imputed values, using multiple regression to predict the missing value based on other variables (age, race, sex, and other IADL items) known to correlate with the variable in question, were used. Because of the correlation between scores on the ADL and IADL scales (r=.68), these imputed values were considered better estimates than assigning a value of 3 ("unable to do the task").

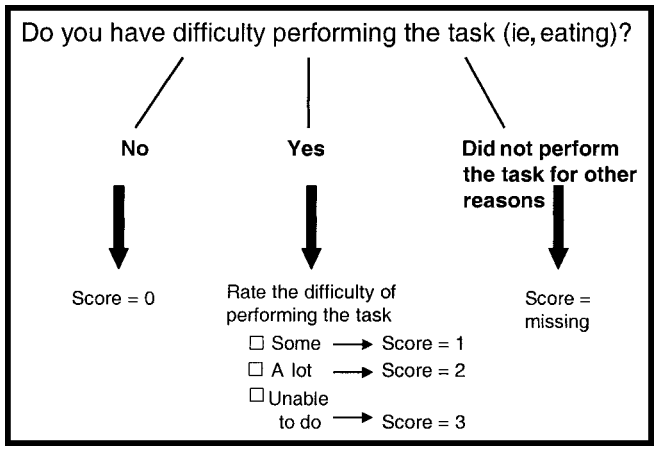

Figure 3.
Scoring algorithm for activities of daily living and instrumental activities of daily living.

Timed Walk (using 2.4-m [8-ft] walk)
0=unable to do
1=≥5.7 s
2=4.1-5.6 s
3=3.2-4.0 s
4=≤3.1 s

Timed Walk (using 2.7-m [9-ft] walk)
0=unable to do
1=≥6.1 s
2=4.51-6.0 s
3=3.51-4.5 s
4=≤3.5 s

Timed Chair Stands
0=unable to do
1=≥16.7 s
2=13.7-16.6 s
3=11.2-13.6 s
4=≤11.1 s

Standing Balance

0	Side-by-side stand: 0-9 s Unable to do in any position
1	Side-by-side stand: 10 s Semi-tandem stand: 0-9 s or unable to do
2	Side-by-side stand: 10 s Semi-tandem stand: 10 s Full tandem stand: 0-2 s or unable to do
3	Side-by-side stand: 10 s Semi-tandem stand: 10 s Full tandem stand: 3-9 s
4	Side-by-side stand: 10 s Semi-tandem stand: 10 s Full tandem stand: 10 s

Figure 4.
Scoring for measures of the Short Physical Performance Battery.[18]

The tasks selected for the ADL and IADL scales were those used in a major national survey of older adults.[16] The grading format, using level of difficulty, was adapted from the Comprehensive Assessment and Referral Evaluation (CARE).[17] The internal consistency values (Cronbach alpha) for the ADL and IADL scales used in this study were .75 and .72, respectively.

Composite scores for ADL and IADL were calculated using the sum of scores for the individual tasks. For ADL and IADL, lower scores indicated less reported difficulty with the functional tasks. For ADL, the scores could range from 0 to 15, with a score of 15 indicating that the subject could not perform any of the tasks. For IADL, the scores could range from 0 to 18, with a score of 18 indicating inability to perform any of the tasks.

Physical performance. The SPPB, which included timed tests of standing balance, walking, and the ability to rise from a chair, was used to measure physical performance.[18,19] The SPPB is described in detail by Guralnik et al.[18] These tests were designed to be administered by a lay interviewer in a setting with limited space. For each

task, scores ranged from 0 to 4, with 4 representing the best performance and 0 indicating that the person was unable to complete the task. Figure 4 includes a description of the scoring categories for each task.

For standing balance, subjects were tested with their feet in 3 positions: side-by-side, semi-tandem, and tandem. Subjects started in the side-by-side position and progressed to the semi-tandem and then tandem positions. To progress to the next position, a subject had to stand unsupported for 10 seconds. For example, the highest score of 4 was assigned if the subject could assume the tandem position and stand unsupported for 10 seconds. To test walking speed, subjects were instructed to walk at their usual speed for 2.7 m (9 ft). Subjects were timed for 2 walks, and the faster of the 2 times was used in the analysis. We calculated walking speeds (in meters per second) to establish cutoff times comparable to those used by Guralnik et al[18] because they used a 2.4-m (8-ft) walk and we used a 2.7-m walk (Fig. 4). For the third task, timed chair stands, subjects were asked to stand up and sit down 5 times as quickly as possible. Subjects were timed from the beginning sitting position to the final standing position of the fifth stand. The test was stopped if subjects became tired or short of breath, if they used their arms, or if the test was not completed within 1 minute. Subjects were assigned a score of 0 to 4 based on the time to complete 5 stands.

Composite scores for the SPPB measure were calculated as the sum of the categorical rankings of each of the 3 tests (standing balance, timed walk, timed chair stands). Composite scores ranged from 0 to 12, with higher scores indicating better performance. The internal consistency of the scale, as assessed by Cronbach alpha, was .76.[18]

Presence of depression. We used the short form of the GDS to determine the presence of depression.[20] This version contains 15 questions and has been shown to be comparable to the long version of the GDS in differentiating between people with and without depression (r=.84).[20] The instrument is scored from 0 to 15, with lower scores indicating a lower number of symptoms of depression.

Cognitive status. We used the MMSE to assess cognitive status.[21] The MMSE takes from 5 to 10 minutes to administer, and scores range from 0 to 30. The MMSE has been determined to yield valid results for differentiating between people with and without cognitive impairment.[21] The exam has demonstrated test-retest reliability when administered over both 24-hour and 28-day intervals using single and multiple examiners.[21]

Availability of transportation. Transportation resources were assessed by asking subjects the following 2 questions: "Over the past 4 weeks, have you had any difficulty getting transportation to where you want to go?" and "Do you limit your activities because you do not have transportation?" People who responded positively to either question were defined as having transportation difficulty and assigned a code of 1. People who responded with a negative answer to both questions were assigned a code of 0.

Table 1.
Sample Age and Test Results[a] (n=998)

Measure	$\bar{X}$	SD	Minimum	Maximum
Age (y)	75.3	6.7	65	106
LSA	64.1	24.9	0	120
ADL	1.1	2.1	0	15
IADL	2.1	3.4	0	18
SPPB	6.8	3.2	0	12
MMSE	25.0	4.8	1	30
GDS	2.4	2.3	0	14

[a] LSA=Life-Space Assessment, ADL=activities of daily living (5 items: eating, toileting, dressing, transferring, bathing), IADL=instrumental activities of daily living (6 items: using the telephone, managing money, preparing meals, doing light housework, shopping, doing heavy housework), SPPB=Short Physical Performance Battery, MMSE=Mini-Mental State Examination, GDS=Geriatric Depression Scale.

Income levels. Total combined family income before taxes was reported in the following 9 categories: 0=less than $5,000; 1=$5,000 to $7,999; 2=$8,000 to $11,999; 3=$12,000 to 15,999; 4=$16,000 to $19,999; 5=$20,000 to $29,999; 6=$30,000 to $39,999; 7=$40,000 to $49,999; and 8=$50,000 or more. The following question also was asked, related to the subjects' perceived income: "All things considered, would you say your income: (1) is not enough to make ends meet, (2) gives you just enough to get by on, (3) keeps you comfortable, but permits no luxuries, or (4) allows you to do more or less what you want?" For people who did not report income (165 subjects), responses indicating perceived income were used to calculate income categories based on the correspondence of income categories and perceived income among people with answers to both questions. Thus, the following coding was used to impute income levels for perceived income categories: 1=$5,000 to $7,999; 2=$8,000 to $11,999; 3=$16,000 to $19,999; and 4=$30,000 to $39,999.

Data Analysis

Descriptive statistics were calculated for all variables for the total sample and for LSA scores for subgroups using categorical variables. Simple bivariate correlation coefficients were used to examine the relationships between LSA scores and all variables, including the individual items on the ADL, IADL, and SPPB tests.

Multiple regression was used to determine the importance of groups of variables for explaining variance in

Table 2.
Life-Space Assessment (LSA) Scores for Subgroups

	LSA Score		
	$\bar{X}$	SD	P[a]
Sex			
Male (n=501)	70.2	24.7	<.001
Female (n=499)	58.0	23.6	
Race			
White (n=500)	71.7	22.9	<.001
African American (n=500)	56.6	24.6	
Age group (y)			
65–74 (n=514)	71.3	23.3	<.001
75–84 (n=373)	60.0	24.3	
85+ (n=113)	45.8	21.7	
Residence			
Urban (n=486)	63.0	24.9	.660
Rural (n=514)	65.2	24.9	
Transportation difficulty			
Yes (n=171)	42.8	18.1	<.001
No (n=829)	68.5	23.8	
Income[b]			
≤$7,999 (n=224)	50.2	21.7	<.001
$8,000–$15,999 (n=229)	59.2	23.6	
$16,000–$29,999 (n=182)	74.8	22.5	
$30,000–$49,999 (n=121)	76.8	22.1	
≥50,000 (n=78)	80.5	24.9	

[a] *t* test for significant differences among sex, race, residence, and transportation difficulty; analysis of variance for significant differences between age groups and income.
[b] Does not include imputed values.

Table 3.
Bivariate Correlation Coefficients Between Life-Space Assessment (LSA) Scores and Variables[a]

Variable	LSA
Age	−.36
Race	−.30
Sex	−.24
Residence (rural vs urban)	.05
Transportation difficulty	−.39
Income	.44
MMSE score	.40
GDS score	−.39
ADL limitation	
Transferring	−.41
Bathing	−.45
Dressing	−.37
Eating	−.20
Toileting	−.36
Composite score	−.49
IADL limitation	
Phone	−.16
Light housework	−.43
Heavy housework	−.48
Preparing meals	−.46
Shopping	−.51
Managing money	−.28
Composite score	−.55
SPPB	
Standing balance	.51
Walking speed	.57
Chair stands	.51
Composite score	.63

[a] ADL=activities of daily living, IADL=instrumental activities of daily living, SPPB=Short Physical Performance Battery, MMSE=Mini-Mental State Examination, GDS=Geriatric Depression Scale. All correlations are Pearson correlations except for race, sex, residence, and transportation difficulty, which are point-biserial correlations. All correlations except for residence are significantly different from 0 (P<.0001, 2-tailed).

the LSA scores. The regression model used sequential entry of the following variable groups: ADL and IADL (step 1); SPPB (step 2); age, race, sex, income, residence, and transportation difficulty (step 3); and MMSE and GDS (step 4). Variables were placed into the 4 categories based on the attribute measured. The steps were ordered to determine first the contribution of traditional measures of physical function, then the contribution of physical performance and sociodemographic factors, and finally the contribution of depression and cognition. As a part of step 4, the unique contribution of each variable was tested for statistical significance after controlling for the contributions of other variables in the model. The SPSS* was used for all statistical analyses.

Results

The subjects' ages and test results are shown in Table 1. Two subjects were not included in the analyses because of missing data (income and GDS score). Fifty-one percent of the subjects were married. Twenty percent had a 6th grade or less educational level, and 27% reported an educational level greater than the 12th grade of high school. Twenty-two percent reported an annual income of $8,000 or less, although the modal income category was $8,000 to $11,999. Seventeen percent of the sample reported having difficulty with transportation.

Overall, the subjects reported more difficulty with IADL than with ADL, as indicated by mean values of 1.1 and 2.1 for ADL and IADL, respectively (Tab. 1). The overall SPPB score was 6.8 (SD=3.2) of a total possible score of 12 (Tab. 1). Of the 3 tasks, subjects scored highest on standing balance. Sixty-three percent of the subjects scored 4 on standing balance, 17% scored 4 on walking speed, and 13% scored 4 on chair stands. For standing balance, walking speed, and chair stands, the percentages of subjects who were unable to perform the tasks were 11%, 11%, and 27%, respectively.

* SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

Table 4.
Sequential Regression Analysis of Correlates of Life-Space Assessment (LSA)

Step	Variable[a]	R^2 for Step	Increment in R^2 After Step
1	ADL, IADL	.328[b]	.328[b]
2	SPPB	.455[b]	.127[b]
3	Age, race, sex, residence, income, transportation difficulty	.582[b]	.127[b]
4	MMSE, GDS	.589[b]	.007[b]

[a] ADL=activities of daily living, IADL=instrumental activities of daily living, SPPB=Short Physical Performance Battery, MMSE=Mini-Mental State Examination, GDS=Geriatric Depression Scale.
[b] Significantly different from 0, $P<.001$.

Table 5.
Relative Contribution of Individual Variables to Life-Space Assessment (LSA) Scores[a]

Variable	Beta (Standardized Coefficients)	*t*	*P*
ADL	−.070	−2.33	.020
IADL	−.195	−6.46	<.001
SPPB	.282	10.05	<.001
Age	−.112	−4.95	<.001
Race	−.057	−2.24	.026
Sex	−.151	−7.05	<.001
Income	.137	5.10	<.001
Residence (rural/urban)	.139	6.49	<.001
Transportation difficulty	−.139	−6.18	<.001
MMSE	.066	2.54	.011
GDS	−.070	−2.92	.004

[a] ADL=activities of daily living, IADL=instrumental activities of daily living, SPPB=Short Physical Performance Battery, MMSE=Mini-Mental State Examination, GDS=Geriatric Depression Scale. $R^2=.59$; adjusted $R^2=.58$; $df=11,986$; $F=128.4$.

The LSA scores for subgroups for categorical variables are presented in Table 2. The mean value for the LSA was 64.1 (SD=24.9). Scores were higher for male subjects, white subjects, and the youngest age group. There was no difference in LSA scores between rural and urban residents. Subjects having transportation difficulty had lower scores than those without transportation difficulty. The LSA scores differed in subjects with varied incomes, with a 30-point difference between subjects in the lowest income level (≤$7,999) and subjects in the highest income category (≥$50,000).

Table 3 presents the bivariate correlation coefficients describing the relationships between LSA and variables, including both the individual items and composite scores for ADL, IADL, and SPPB. With the exception of residence (rural versus urban), all correlations differed significantly from zero. Because race was coded as 0=white and 1=African American and sex was coded as 0=male and 1=female, the negative correlations for these variables reflect higher LSA scores for white subjects and male subjects. The negative correlations for ADL and IADL indicate an inverse relationship between LSA and ADL and IADL. The lowest coefficients were for eating, using the telephone, and managing money—activities that involve a low level of physical activity. The highest coefficients were for shopping and for the physical performance tasks. Correlations with LSA scores were higher for the composite scores of ADL, IADL, and SPPB than for any individual item.

A summary of the results of the sequential regression analysis is presented in Table 4. Each group of variables uniquely explained a significant proportion of variance in LSA scores after covariate adjustment of variables entered in previous steps. Variables that measure physical function (ADL, IADL) were entered first and accounted for 32.8% of the variance in LSA scores. Adding a measure of physical performance (SPPB) explained 45.5% of variability in LSA scores. This finding indicates that less than half of the variability in LSA scores was explained by these 3 traditional measures of physical status. An additional 12.7% of the variance in LSA scores was explained by 6 sociodemographic variables (age, race, sex, income, residence, and transportation difficulty). Adding cognitive status (MMSE) and depression significantly increased the variance accounted for in LSA scores, but the size of the effect was quite small (less than 1%).

A summary of results of the regression model that included all variables after step 4 is shown in Table 5. Variables that uniquely accounted for a relatively high proportion of the variance in LSA scores were SPPB, sex, and IADL. More moderate contributions were found for urban versus rural residence, transportation difficulty, income, and age. Variables with smaller contributions to the model were race, MMSE, GDS, and ADL. The adjusted squared multiple correlation coefficient (R^2) indicates that 58% of the variance in LSA scores was explained by the final multiple regression model.

Discussion

This study demonstrated that the UAB Study of Aging LSA, a measure of mobility for community-dwelling older adults, reflects not only traditional assessments of physical function and physical performance (ADL, IADL, and SPPB), but also sociodemographic factors and, to a lesser extent, neuropsychological factors (MMSE and GDS). If the desired outcome of physical therapy is enhanced mobility, then the LSA may be an appropriate instrument to determine baseline mobility

levels and to track changes that occur with interventions. By knowing the factors that contribute to LSA scores, physical therapists can form clinical hypotheses to explain mobility deficits and can design plans of care to address contributing factors.

Most of our sample of community-dwelling older adults had little difficulty with ADL or IADL. For ADL, 85% of the subjects scored 0, 1, or 2 out of a total composite score of 15, indicating no difficulty with any of the tasks, some difficulty with 1 or 2 tasks, or a lot of difficulty with a single task. For IADL, 70% of the subjects scored 0, 1, or 2 of a possible 18 points. These scores, indicating high levels of independence, may be influenced by the omission of the items "walking" and "getting outside." Physical performance and LSA scores showed more variability. Two thirds of the subjects fell between 3.6 and 10 for SPPB scores, and two thirds of the subjects fell between 39 and 89 for LSA scores. The modal income category of $8,000 to $11,999 indicates an approximate income below the poverty line for families of 3 people in Alabama.[22] For a family of 2 people with the householder 65 years and older, an annual income of $10,715 was the threshold for poverty in 2001 ($8,494 for an individual 65 years and older).[23] Only 17% of the sample expressed difficulty with transportation, and most subjects did not demonstrate symptoms of depression. Considering the educational levels of our subjects and the relationship between MMSE and education,[24] the average MMSE score indicates that most subjects had minimal or no cognitive impairment. In our sample, there were 50 subjects with MMSE scores <18 who did not use a proxy during the interview. However, eliminating these subjects from the analysis did not change the results of the study.

With the exception of residence (rural versus urban), the simple bivariate correlations were significant. The highest correlations were between LSA scores and the composite scores for SPPB, IADL, and ADL. Of the individual tasks for SPPB, the highest correlation was with walking speed, followed by chair stands and standing balance. Of the individual items of IADL and ADL, the smallest correlations were between LSA scores and scores for items requiring low levels of physical activity, such as eating, using the telephone, and managing money. Higher correlations occurred with more physically demanding tasks such as bathing, housework, and shopping. People who travel more with less assistance would be expected to have less difficulty with the physically demanding ADL and IADL tasks.

The negative correlations between LSA scores and transportation difficulty and GDS scores indicated that people without transportation difficulty and people with low GDS scores (less depressive symptoms) had higher LSA scores. The positive moderate correlation between LSA and MMSE scores indicates that people scoring higher on the MMSE tended to have higher LSA scores.

The sequential regression analysis showed that the 3 variables measuring physical abilities (ADL, IADL, and SPPB) explained 45.5% of the variability in LSA scores. The ability to carry out ADL tasks such as bathing and dressing with little or no difficulty is necessary for independent mobility in the community. Greater levels of physical function are necessary for traveling to town and beyond frequently and independently. An additional 12.7% of the variability in LSA scores was explained by 6 sociodemographic factors. As shown in Table 2, LSA scores were higher for male subjects, white subjects, younger subjects, people without transportation difficulty, and people with higher incomes. Although the contribution of cognition and depressive symptoms was significant, these variables explained only a small portion of the variability in LSA scores.

The regression model using entry of variables after step 4 provides information on the independent contribution of each variable when all other variables are covariates. Residence, which did not demonstrate a significant relationship in the simple bivariate correlational analysis, emerged as a significant contributor to LSA scores when other factors were controlled. In an attempt to explain this finding, we examined differences between rural and urban subjects. Rural subjects had lower incomes, with 35% having incomes of less than $8,000 per year, compared with 18% of the urban subjects. Rural residents also were more physically disabled as indicated by higher ADL and IADL scores and lower SPPB scores. Rural residents had slightly lower MMSE scores. These differences, particularly income, probably accounted for the shift in significance from the bivariate analysis to the multiple regression analysis. After statistically adjusting for these differences between urban and rural subjects on other variables such as income, rural residents were then found to have higher LSA scores, as indicated by the positive beta and *t* values. Perhaps this is because rural residents travel farther to accomplish tasks. In addition, some community services enabling residents to stay at home, such as Meals on Wheels, may be unavailable in rural communities.

The 3 variables that made the greatest contributions to LSA scores were SPPB, IADL, and sex. People with high LSA scores are able to travel independently in their community. Having no difficulty with IADL also reflects the ability to accomplish tasks necessary to live independently within a community. High scores on the SPPB reflect the ability to walk fast, stand up and down quickly, and stand in a challenging position without support. The contributions of SPPB and IADL support our view that a

person's physical abilities are an important determinant of life-space. With age and other variables controlled, sex emerged as a significant determinant of life-space, with men demonstrating higher LSA scores than women. Epidemiological studies, using ADL, IADL, and mobility assessments, have shown that older women are more disabled than older men.[25,26] Our findings concur with those of these studies, identifying sex differences in mobility as an important women's health issue.

In addition to residence, variables that explained a moderate amount of variability were age, transportation difficulty, and income. Compared with the youngest age group, older subjects demonstrated a lower level of physical function, as indicated by higher scores for ADL and IADL and lower SPPB scores. The oldest age group (people aged 85 years and older) averaged 2.0, 3.5, and 4.5 for ADL, IADL, and SPPB compared with scores of 0.8, 1.0, and 7.7, respectively, for the youngest age group of 65 to 74 years. People having difficulty with physical activities would be likely to need assistance with travel. People reporting transportation difficulty would have difficulty with travel to and beyond town (life-space levels 4 and 5). Independent travel to these areas involves being able to drive and having a vehicle or having access to a vehicle, or being able to use public transportation. People with lower income levels may have less access to transportation or may travel less for activities that involve spending money such as shopping or eating out.

The variables that explained the least amount of variance in LSA were ADL, GDS, MMSE, and race. Activities of daily living may not be a good discriminator, because most of the subjects had little or no difficulty with ADL. It may be difficult to determine the true impact of depression and cognitive impairment on life-space from our results because of the low prevalence of both depression and cognitive impairment in our sample. Even with other variables controlled, African-American subjects had lower LSA scores, indicating that this lower level of mobility is not explained by differences in physical abilities, income levels, or other variables in the multivariate model.

The value of the LSA instrument is that the instrument goes beyond measuring a person's ability to perform specific tasks by assessing the individual's actual pattern of mobility in the 4 weeks before the assessment. A patient may have a low LSA score, yet be physically capable of traveling independently in the community. Recognizing the importance of factors other than physical function, physical therapists can explore with patients reasons why life-space is limited. For example, identification of socioeconomic or emotional factors that may be influencing life-space can lead to referrals to other health care professionals such as a social workers or psychologists. Identifying impaired cognition or depression as a factor contributing to low mobility can help physical therapists estimate patients' prognoses for improved mobility. An important feature of the LSA is that the instrument documents what patients actually do, allowing therapists to gather information on actual home and community mobility using a standardized instrument. This assessment can be used over time to track changes in life-space mobility. Demonstration of a decline in life-space may indicate early functional decline, providing a period when interventions are more likely to be successful.[27]

A limitation of this study is the use of derived scores for income and for the ADL and IADL tasks for some subjects. Relative to the total number of subjects, the number of subjects with derived scores was low. Because of the strength of association with variables that were used to generate derived scores, these derived values are considered good estimates of the true values.

Advantages of the LSA include the length of the instrument, which can be administered in approximately 5 minutes, and the manner of administration of the instrument, which can occur either face-to-face or over the telephone. A potential limitation of the LSA is that the information collected by patient self-report may be a problem for older adults who have difficulty remembering events over the past month. Interviewing the patient in the presence of a spouse or caregiver would provide a second person to validate information reported by the patient. A second potential limitation is that the LSA was developed and tested using subjects from the southeastern United States. Scores may differ in other parts of the country because of differences in the typical distances that people must travel and differences in climate.

Conclusion

This report presents a standardized method of assessing mobility in the home and community using a unique tool. In this sample of 998 community-dwelling older adults, there were significant bivariate correlations between LSA scores and sociodemographic variables (age, race, sex, income, transportation difficulty), physical performance, ADL, IADL, cognitive function, and depression. A multiple regression model using sequential entry of groups of variables demonstrated that 45.5% of the variability in LSA scores could be explained by measures of physical abilities (ADL, IADL, and SPPB), 12.7% could be explained by sociodemographic variables, and an additional 0.7% could be explained by cognition and depression. The regression model explained 58% of the variability in LSA, with the most important variables being SPPB, IADL, and sex. Thus, the LSA can be used by physical therapists as an outcome

assessment of mobility, complementing traditional methods that measure impairments or functional limitations.

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