Life-Space and Cognitive Decline in a Community-Based Sample of African American and Caucasian Older Adults

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Abstract

Background—Life-space, a measure of movement through one's environment, may be viewed as one aspect of environmental complexity for older adults. We examined the relationship between life-space and subsequent change in cognitive function.

Methods—Participants were 624 community-dwelling Medicare beneficiaries (49% African American) who completed in-home assessments at baseline and follow-up 4 years later. The Life-Space Assessment was used at baseline to measure extent, frequency, and independence of participants' movement within and outside the home. Cognitive decline was measured with the Mini-Mental State Examination (MMSE).

Results—In a regression model adjusted for baseline MMSE, age, gender, race, residence (rural/urban), and education, greater life-space at baseline predicted reduced cognitive decline ($\beta = -.177$, $p < .001$). This association remained statistically significant in subsequent models that examined what proportion of the observed association was explained by baseline physical activity, physical function, vascular risk factors, comorbidity, and psychosocial factors. Physical function accounted for the largest proportion (37.3%) of the association between life-space and cognitive decline. There was no significant interaction between life-space and race, gender, or age in predicting cognitive decline. In a logistic regression analysis, participants in the highest quartile of life-space had 53% reduced odds of substantial cognitive decline (≥ 4 points on MMSE) compared to those in the lowest quartile.

Conclusions—These preliminary findings suggest that life-space may be a useful identifier of older adults at risk for cognitive decline. Future research should investigate the potential reciprocal relationship between life-space and cognitive function as well as the interrelationship between these factors and physical function.

Keywords

Life-space; Cognition; Older adults; Cognitive decline

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A better understanding of factors associated with cognitive aging can inform intervention strategies as well as help identify individuals at greatest risk of cognitive decline so that treatments may be targeted appropriately. One longstanding theory of cognitive aging holds that greater complexity of living environment is protective against cognitive decline in older adulthood (1), and there is recent evidence that range of environmental movement is positively associated with global cognitive function (2,3). It is possible that a general measure of living environment, such as life-space, may be complementary to measures of various specific activities for investigating the proposed link between environmental complexity and cognitive function.

Life-space has been conceptualized as a measure of mobility, given that it reflects the area through which a person moves over a specified time period (4). However, getting out of the house more often and traveling greater distances on a regular basis may also be viewed as one component of environmental complexity for older adults. Environments that provide greater diversity of experiences and greater demands in terms of decision making are considered to be more complex (1). Having a restricted life-space may lead to reduced diversity of experiences as well as limit everyday environmental demands. Evidence from a large number of animal studies suggests that a more enriched environment can lead to improved brain function via mechanisms such as increased dendritic complexity, neurogenesis, and gliogenesis (5). In humans, environmental complexity measured by leisure-time activity engagement and job characteristics has been found to positively influence cognitive function (6,7).

The association between life-space and subsequent cognitive decline has not been previously reported. We used data from the University of Alabama at Birmingham (UAB) Study of Aging, a longitudinal study of mobility among community-dwelling African Americans and Caucasians (2), to examine the hypothesis that greater baseline life-space would be associated with reduced cognitive decline 4 years later. We did not expect this association to be fully explained by demographic factors, physical function, physical activity, medical problems, or psychosocial factors. Given that apathy and reduced social engagement may be prodromal symptoms of dementia (8,9), diminished life-space may reflect prior cognitive decline. Although we could not directly account for prior cognitive decline, we controlled for baseline cognitive function. We were particularly interested in examining the role of physical function because of the strong association between life-space and physical function (4,10) and recent evidence that indicators of poor physical function may predict cognitive decline and dementia in older adults (11–13). We did not expect the relationship between life-space and cognitive decline to be modified by race, gender, or age.

Methods

Participants

This analysis used data from the UAB Study of Aging, a population-based longitudinal study of adults 65 years old or older in five counties of central Alabama (2). A random sample of 1000 older adults was initially recruited from a list of Medicare beneficiaries stratified by race (African American/Caucasian), county (rural/urban), and gender to achieve a balanced sample with respect to these factors. Individuals living in nursing homes or unable to schedule their own appointments were excluded. Data collection was targeted at elucidation of factors related to mobility and everyday function, and was gathered via in-home interviews at baseline and 4 years later. A complete description of the study design and measures has been previously published (2).

The sample for the current analysis included participants completing in-home assessments 4 years after baseline, at which time cognitive function was measured again. Of the initial 1000 participants, 775 were alive and not living in a nursing home at 4-year follow-up; 624

participants (81%) agreed to be interviewed in their homes. Nonparticipants did not differ from participants in terms of gender, urban/rural residence, or race ($p > .05$). However, nonparticipants were older and reported lower levels of education ($p < .05$).

Measures

Cognitive decline was measured using change in Mini-Mental State Examination (MMSE) (14) from baseline to 4 years later. MMSE scores range from 0 to 30, with higher scores indicating better cognitive function. The main independent variable of interest, life-space, was measured using the UAB Study of Aging Life-Space Assessment (LSA) (4). Scores on the LSA range from 0 to 120, with higher scores reflecting greater life-space. Participants reported frequency of movement (how many days within a week) during the 4 weeks prior to assessment for five different life-space "levels" consisting of: "rooms of your home besides the room where you sleep"; "an area outside your home such as your porch, deck or patio, hallway of an apartment building, or garage"; "places in your neighborhood, other than your own yard or apartment building"; "places outside your neighborhood but within your town"; and "places outside your town." Participants were also asked whether they had assistance from another person or devices to attain each level of life-space. Overall life-space score was computed by summing the products of life-space level (1–5) by degree of independence (2 = independent, 1.5 = used equipment, 1 = had personal assistance) by frequency of attainment (1 = less than once per week, 2 = 1–3 times per week, 3 = 4–6 times per week, 4 = daily). This measure shows a normal distribution for both African American and Caucasian participants (15). Pilot testing revealed that the scoring method was superior to several other scoring methods in terms of normality of distribution as well as correlation with factors associated with mobility (4).

Covariates included age, race (African American/Caucasian), gender, education, and residence (urban/rural) self-reported at baseline. Two of the five counties from which participants were recruited were classified as urban and three were rural (16). Education was collected by asking participants to report the highest grade completed, which was recorded as: sixth or less, seventh through eleventh, high school, some college, completed technical or junior college, college graduate, some graduate/professional school, or graduate/professional degree. Post-high school categories were subsequently collapsed into one level of classification.

Physical activity, physical function, vascular risk factors, comorbidity, and psychosocial factors were examined as potential explanatory variables. Physical activity was measured using the leisure-time physical activity assessment from the Cardiovascular Health Study (17). Participants reported frequency and duration of participation in 15 different types of activities during the past 2 weeks. These activities included walking, doing household chores, mowing, raking, gardening, hiking, jogging, biking, exercise cycling, dancing, doing aerobics, bowling, golfing, exercising (general), and swimming. Physical activity was scored as kilocalories expended per week. The Short Physical Performance Battery (SPPB) (18) was used to assess physical function. The SPPB includes timed tests of standing balance, walking, and ability to rise from a chair, each of which are scored on a 0 (unable to complete task) to 4 (best possible performance) scale. The composite SPPB score was calculated as the sum of scores on the three individual tests, with a range of 0–12.

Vascular risk factors included hypertension, diabetes, myocardial infarction, congestive heart failure, and stroke collected by self-report with physician, hospital discharge, or medication verification at baseline. Comorbidity was measured using a count of conditions included in the Charlson Comorbidity Index (19). Conditions included the vascular risk factors above, chronic obstructive pulmonary disease (COPD), kidney failure, liver disease, non-skin cancer, valvular heart disease, peripheral artery disease, neurological disease, and gastrointestinal disease. Conditions were considered verified if the participant was prescribed a medication for the

condition, if the primary physician returned a questionnaire indicating the condition, or if a hospital discharge summary in the previous 3 years indicated the disease.

Psychosocial factors included depressive symptoms and social support. Depressive symptoms were assessed using the 15-item Geriatric Depression Scale (GDS) (20). This instrument involves asking participants for yes/no responses to potential depressive symptoms experienced in the past week. Higher scores reflect greater depressive symptoms. Information on social support was collected using a modified four-item scale from the revised Arthritis Impact Measurement Scales (21). Responses on each item are scored on a 0 (always) to 4 (never) scale, with an overall social support score ranging from 0 to 16. Higher scores indicate less perceived support.

Data Analysis

We used linear regression and logistic regression models to examine the association between life-space and cognitive decline. In our basic linear model, we regressed change in MMSE score on life-space, baseline MMSE score, age, gender, race, urban/rural residence, and education. We then examined the individual roles of physical activity, physical function, vascular risk factors, comorbidity, and psychosocial factors in explaining the association between life-space and cognitive change by adding each of these factors separately to the basic model. To investigate whether the association between life-space and cognitive decline was modified by race, gender, or age, we refitted the basic model while including an interaction term of the respective factor by mean-centered life-space.

We examined whether results were affected by inclusion of individuals with baseline cognitive impairment by refitting the basic model excluding participants with initial MMSE scores <21, a cutoff suggested for cognitive dysfunction in samples that include participants with lower levels of education (11,22). We used logistic regression to examine odds of cognitive decline as a categorical variable, with substantial cognitive decline defined using the previously reported cutoff of a change of four or more points on the MMSE within a 4-year period of time indicating significant deterioration (23). This cutoff also corresponded to 1 standard deviation (*SD*) above mean MMSE decline in the current sample. The logistic regression analysis was performed to enhance interpretation of findings in terms of clinical relevance. In the logistic regression model, we adjusted for covariates included in the basic linear model and examined life-space as a categorical predictor (quartiles). All analyses were performed using SAS (24).

Results

Sample characteristics for the 624 participants are presented in Table 1. Average age was 74 years, 49% of the sample were African American, 53% were female, and 49% resided in a rural area. Approximately 44% of the sample had less than a high school education. Average 4-year decline in MMSE score was 1.0 points (*SD* = 3.0), with approximately half the sample showing some decline during this time period. In terms of vascular risk factors, more than half the sample had hypertension, and approximately one-quarter of the sample had diabetes at the time of baseline assessment. Average life-space scores were higher among younger and more educated participants, Caucasians, and men (Table 2). Correlation with life-space was .31 for baseline MMSE, −.27 for age, −.28 for gender, −.32 for race, and .31 for level of education (*p* < .001 for each). The number of participants who achieved each level of life-space and assistance needed for attainment of each level is presented in Table 3. Only one participant reported life-space restricted to the bedroom. With increasing levels of life-space, there were fewer participants who attained a given level. Even at the highest levels of life-space, most participants did not report needing help from another person or using aids or equipment.

In our basic model, adjusted for baseline MMSE, age, gender, race, urban/rural residence, and level of education, there was a significant association between life-space and cognitive decline (Table 4). Greater life-space was associated with reduced cognitive decline over the 4-year period. In subsequent models adjusted for physical activity, physical function, vascular risk factors, comorbidity, and psychosocial factors, life-space remained a significant predictor of cognitive decline. Of these covariates, physical function showed the largest contribution to the relationship between life-space and cognitive decline (37.3%), followed by psychosocial factors (11.9%), vascular risk factors (9.4%), comorbidity (4.5%), and physical activity (2.3%).

Because previous reports have demonstrated an association between life-space and race, age, and gender (10,15), we repeated the basic model with terms for the interaction of life-space with each of these demographics. There was no evidence that the association between life-space and cognitive decline was modified by race, gender, or age ($p > .05$ for each interaction term). When we ran the basic model after excluding participants with poor baseline cognitive function (MMSE < 21), life-space remained a significant predictor of cognitive decline ($p < .0001$). We also examined cognitive decline and life-space as categorical variables using logistic regression. Participants in the highest quartile for life-space had reduced odds of substantial cognitive decline (≥4 points on MMSE) by about 50% compared to participants in the lowest quartile after adjustment for baseline MMSE, age, gender, race, urban/rural residence, and level of education (odds ratio = 0.47; 95% confidence interval, 0.24–0.95).

Discussion

In this sample of community-dwelling African American and Caucasian older adults, we found that life-space predicted 4-year cognitive decline. Individuals with greater life-space at baseline experienced significantly less decline. This association was not fully explained by differences in baseline cognitive function, demographic factors, physical activity, physical function, vascular risk factors, comorbidity, or psychosocial factors. Additionally, the relationship between life-space and cognitive decline did not differ significantly by race, gender, or age. When cognitive decline and life-space were examined as categorical variables, we found that individuals with high life-space (75th percentile) had approximately half the odds of substantial cognitive decline compared to individuals with low life-space (25th percentile). The findings suggest that having greater life-space may be a protective factor for cognitive decline in older adulthood.

No prior studies have reported the association between life-space and subsequent cognitive decline. Barnes and colleagues (3) examined correlates of a nine-point life-space scale in a cross-sectional study using a sample recruited predominantly from community care and subsidized housing facilities. Greater life-space was correlated with better global cognition. Examination of baseline data from the UAB Study of Aging also showed a positive association between life-space and cognition in cross-sectional analyses adjusted for sociodemographics, general health factors, and depression (2). Our results build on previous findings by providing evidence for an association between life-space and cognitive change.

More than one third (37.3%) of the association between life-space and cognitive decline was accounted for by physical function, assessed using a validated objective measure (18). This finding is not necessarily surprising given the previously reported associations between life-space and physical function (3,4,10) and between aspects of physical function and cognitive function (11–13). Conversely, physical activity, which may be considered a proxy for physical function, accounted for only a small portion (2.3%) of the association between life-space and cognitive decline. These findings further underscore the possible relative importance of physical function in cognitive change. Another interesting finding was that vascular risk factors explained a greater portion of the association between life-space and cognitive decline than

did comorbidity, despite their inclusion in the comorbidity measure. This could be because of the general nature of the comorbidity measure and may suggest that more specific measures are better suited to capture the role of health in cognitive change.

Our findings may be viewed as being partially consistent with the hypothesis that greater environmental complexity is beneficial for cognitive aging (6). We were able to rule out a number of alternative potential explanations for the association between life-space and decline. Still, it is unlikely that life-space alone equals complexity of living environment. Rather, life-space may be one component of environmental complexity that can complement other components, such as social and mental activity, in identifying persons who are at greatest risk of cognitive decline. In addition, the extent to which there may be reciprocal effects between cognitive function and aspects of environmental complexity such as life-space is unknown.

A limitation of the current study is that life-space was measured with self-report, which can be subject to recall bias, especially among persons with cognitive dysfunction. Also, a small or diminished life-space could reflect prior cognitive decline due to incipient dementia rather than contribute to future cognitive decline, especially because social withdrawal and apathy are key symptoms of dementia (8,9). Because dementia diagnoses were not performed, we could not directly address this possibility. However, all analyses controlled for baseline cognitive function, and results were similar after exclusion of individuals with poor baseline cognitive performance (MMSE < 21), reducing the likelihood that the observed relationship between life-space and cognitive decline was due to pre-existing cognitive impairment. Still, further research is needed regarding the utility of assessing life-space in the context of dementia.

Because life-space was only measured in older adulthood, we cannot make any conclusions about the potential relationship between life-space across the life span and cognitive function in older age. In addition, only one in-home follow-up measurement was available, so we were unable to test whether change in life-space precedes change in cognitive function. Inclusion of more detailed neurocognitive testing would have improved the study design as well.

Conclusion

Our findings suggest that life-space may be a useful factor to include in risk profiles to identify individuals who are at greatest risk of cognitive decline. If persons at greatest risk of decline are more accurately identified, prevention efforts may be targeted more appropriately. Also, if the current findings withstand replication, the possibility exists that interventions designed to increase life-space may also have beneficial effects on cognitive function in older adulthood.

Acknowledgments

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Table 1

Characteristics of Participants

Characteristic	*N* = 624
Age, mean (*SD*)	73.8 (5.9)
African American, %	48.6
Female gender, %	53.2
Rural, %	49.0
Level of education	
0–6 years, %	18.6
7–11 years, %	25.6
12 years, %	25.5
13 or more years, %	30.3
Baseline MMSE (0–30), mean (*SD*)	26.1 (3.9)
4-Year change in MMSE, mean (*SD*)	1.0 (3.0)
Life-space (0–120), mean (*SD*)	69.8 (22.8)
Physical activity (kcal/wk), mean (*SD*)	1399.9 (1989.2)
Physical function, mean (*SD*)	7.3 (3.0)
Vascular risk factors	
Hypertension, %	69.9
Diabetes, %	22.1
Myocardial infarction, %	7.5
Congestive heart failure, %	7.2
Stroke, %	8.0
Comorbidity index, mean (*SD*)	2.0 (1.5)
Depressive symptoms (0–15), mean (*SD*)	2.0 (2.1)
Social support (0–16), mean (*SD*)	13.9 (2.9)

Note: SD = standard deviation.

Table 2

Mean Life-Space Scores for Demographic Subgroups ($N = 624$)

Characteristic	Mean	SD	p
Age			<.001
65–74	73.7	21.7	
75–84	65.8	22.9	
85+	53.4	22.2	
Race			<.001
African American	62.3	23.3	
Caucasian	76.9	19.9	
Gender			<.001
Male	76.8	22.0	
Female	63.7	21.8	
Residence			.230
Urban	68.8	22.5	
Rural	70.9	23.2	
Years of education			<.001
0–6	59.7	23.9	
7–11	62.7	22.2	
12	76.1	22.4	
13 or more	76.9	18.8	

Notes: p values from *t* test for race and gender, analysis of variance for age group and level of education.

SD = standard deviation.

Table 3

Assistance Needed for Attainment of Each Life-Space Level (*N* = 624)

	Number Who Reached the Life-Space Level	Number Who Used Aids or Equipment	Number Who Needed Help From Other Person
1 (rooms in home other than bedroom)	623	61	5
2 (area outside home on property)	620	80	8
3 (neighborhood but outside property)	617	98	27
4 (outside neighborhood, within town)	611	98	107
5 (outside town)	478	66	117

Table 4

The Association of Life-Space With Change in Cognitive Function Using Various Multiple Regression Models

Model*	Estimate	SE	β	p	Change in β for Life-Space	Adjusted R^2
1	−.023	.006	−.177	<.001	NA	.138
2	−.023	.006	−.173	<.001	2.3%	.137
3	−.015	.007	−.111	.027	37.3%	.148
4	−.021	.006	−.161	<.001	9.4%	.140
5	−.022	.006	−.169	<.001	4.5%	.137
6	−.020	.006	−.156	.001	11.9%	.140

Notes: Number 1 indicates the basic model, adjusted for baseline Mini-Mental State Examination score, age, gender, race, urban/rural residence, and level of education; 2, model 1 plus adjustment for physical activity; 3, model 1 plus adjustment for performance-based physical function; 4, model 1 plus adjustment for vascular risk factors; 5, model 1 plus adjustment for comorbidity score; 6, model 1 plus adjustment for psychosocial factors.

SE = standard error; NA = not applicable.