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Title: Identification of Older People at Risk of ADL Disability Using the Life-Space Assessment : A Longitudinal Cohort Study

Year: 2016

Version:

Please cite the original version:

Portegijs, E., Rantakokko, M., Viljanen, A., Sipilä, S., & Rantanen, T. (2016). Identification of Older People at Risk of ADL Disability Using the Life-Space Assessment : A Longitudinal Cohort Study. Journal of the American Medical Directors Association, 17(5), 410-414. https://doi.org/10.1016/j.jamda.2015.12.010

Published in Journal of the American Directors Association 2016.
DOI: 10.1016/j.jamda.2015.12.010

Identification of older people at risk of ADL disability using the Life-Space Assessment – a longitudinal cohort study

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Key words: Mobility limitation, Frail, Disability, Participation, Activities of Daily Living, Aging

Running headline: LSA to identify risk for ADL disability

Identification of older people at risk of ADL disability using the Life-Space Assessment – a longitudinal cohort study

Objectives. Life-space mobility, assessed with the Life-Space Assessment (LSA), reflects an individual's mobility in terms of the spatial area, frequency, and need for assistance. The aims were to study associations between life-space mobility and disability status in activities of daily living (ADL), and to define cut-off scores for baseline LSA and LSA change over time identifying individuals who developed ADL inability during two years of follow-up. Robustness of the cut-off scores was tested accounting for potential confounders.

Design. Longitudinal analyses of the "Life-space mobility in old age" cohort study.

Setting. Home-based interviews at baseline and phone interviews two years later.

Participants. Seven-hundred-fifty-five community-dwelling 75-90-years-old people living in Central Finland.

Measurements. LSA score (range 0-120) and ADL disability status (no difficulty, difficulty in ≥1 tasks, or inability in ≥1 tasks) were determined based on self-reports.

Results. Participants who developed difficulty or inability in ADL over time presented lower LSA scores at baseline and larger declines compared to those who remained without task difficulty or inability during the follow-up, respectively. Sensitivity and specificity analyses showed that baseline LSA ≤52.3 (0.86 and 0.74, respectively) and LSA decline of >11.7 (0.76 and 0.71, respectively) identified participants who developed ADL inability over the follow-up. Multinomial regression showed that, after adjustment for potential confounders, these cut-off scores increased the odds to develop *new* difficulty in ADL tasks, and the odds to develop ADL inability among those with baseline difficulty.

Conclusion. Our results suggest that restrictions and declines in life-space mobility may be early signs of increasing vulnerability to disability in old age. These longitudinally-defined cut-off points may help to find clinical applications for the LSA.

INTRODUCTION

Mobility is one of the key components of independent functioning.[1] Life-space mobility - assessed with the Life-Space Assessment (LSA) - reflects the size of the spatial area a person purposely moves through in daily life, the frequency of travel within a specific time, and the need for assistance, irrespective of the mode of transportation.[2] Restricted life-space mobility caused by narrowing of the spatial area where a person moves through or by reducing the frequency of movement limits an individual's opportunities to participate in out-of-home activities.[2,3] Reduced life-space mobility may also be a way to compensate for or to accommodate one's activity to declined functional abilities.[4] The LSA assesses in-home as well as out-of-home mobility, consequently life-space mobility encompasses a range of activities, such as activities of daily living (ADL), and out-of-home activities, such as walking, driving or social activities.[2] When life-space mobility becomes more limited, theoretically, activity restriction and declining physical activity may lead to a vicious circle of declining health and function,[5-7] and eventually, to loss of independence.[8,9]

Restrictions in life-space mobility have been suggested as an early indicator of vulnerability to health decline.[5,7] Several researchers have aimed to identify critical levels for the LSA that indicate poor health outcomes. According to the authors of the scale, 60 points describes a life-space that is mainly restricted to the neighborhood area.[10] In subsequent studies they have shown that a LSA score of 60 is associated with poorer physical and cognitive function.[11] Additionally, Shimada et al.[5] suggested that LSA≤56 indicated limitations in instrumental ADL. Few studies have looked at the impact of declines in LSA. A 10 point decline in LSA has been considered clinically meaningful based on theory [2] and statistical testing (method error).[12] Establishing relevant cut-off points for future health outcomes may provide evidence for clinical relevance of the LSA, for community-dwelling older populations especially. Previous studies have shown that the LSA is a relatively easy to administer questionnaire, which validity and reliability have been established.[2,12,13] In addition, the information may also be reliably obtained from proxy reports.[14]

Development of ADL disability is a commonly used outcome in epidemiological research,[9,15] it has clinical relevance and is meaningful to older people. Cross-sectional studies showed that poorer life-space mobility was associated with disability in ADL.[16-18] Lower frequencies of going outdoors were shown to increase the odds for incident disability in ADL.[19] The aims of this study were to study associations between life-space mobility and ADL disability status (no difficulty, difficulty in ≥1 tasks, or inability in ≥1 tasks) in community-dwelling 75-90-years-old people, and to define cut-off scores for baseline LSA and LSA change over time identifying individuals who developed ADL inability during two years of follow-up. Subsequently, robustness of the cut-off scores for predicting difficulty and inability in ADL was tested accounting for age, sex, number of chronic diseases, physical performance, and cognitive function.

METHODS

These data are from “Life-space mobility in old age” (LISPE) cohort comprising 75-90-years-old community-dwelling people living in Muurame and Jyväskylä in Central Finland. The study design and methods have been published previously.[20,21] Briefly, a random sample of 2550 was drawn from the population register. These persons were informed about the study by a letter and interviewed over the phone to determine interest and eligibility for participation (living independently, able to communicate, residing in recruitment area and willing to participate). Baseline data (N=848) were collected in a home interview. One (N=816) and two (N=761) years later participants were re-interviewed over the phone. By the time of the second follow-up 15 participants had moved to an institutional care facility, 41 participants had died, 12 participants were excluded due to communication problems and 6 participants due to a move outside of the study area. In addition there were non-respondents due to poor health (n=5), unwillingness to participate (n=6) or being out of reach (n=2). Participants signed an informed consent prior to the data collection. The study was approved by the University of Jyväskylä Ethical Committee.

Main variables

Self-reported **life-space mobility** during the preceding four weeks was assessed annually with the 15-item University of Alabama at Birmingham Study of Aging Life-Space Assessment (LSA) with established validity and reliability.[2,13] For each life-space level (bedroom, other rooms, outside home, neighborhood, town, beyond), participants were rated according to how many days a week they attained that level and whether they needed help from another person or assistive devices. A composite score reflecting the distance, frequency and assistance was calculated (range 0-120); higher scores indicate greater mobility.

Self-reported **difficulty and inability in ADL** tasks (feeding, getting up from bed, dressing, bathing, and toileting) was assessed at baseline and at the two-year follow-up.[20] ADL difficulty was defined as reporting some or a great deal of difficulty in one or more tasks, while ADL inability was defined as being unable to perform one or more tasks with or without the help of another person.

Other variables

Age and **gender** were derived from the national population register. Other information was obtained during the baseline home interview. Self-reported **number of chronic diseases** was calculated from a list of 22 physician diagnosed chronic diseases and an additional open-ended question about any other physician diagnosed chronic conditions.[20] The Mini-Mental State Examination score (range 0-30) was used as an indicator of **cognitive function**.[22] Data of one participant were excluded from all adjusted analyses due to severely impaired sight that obstructed the administering of the Mini-Mental State Examination. **Lower extremity performance** was objectively assessed by the Short Physical Performance Battery, comprising of three tests that assess standing balance, walking speed over 2.44 meters, and five timed chair rises. Each task was rated according to established age- and gender-specific cut-off points, and a sum score (range 0-12) was calculated.[23,24] Data of nine participants were excluded from all adjusted analyses because of missing SPPB due to a temporary medical condition, wheel chair use, severely impaired sight, lack of suitable chair for testing or unwillingness to cooperate.

Statistical analyses

Participants with more than one missing ADL item (N=5 at follow-up) and missing LSA scores (N=4 at follow-up) were excluded from the respective analyses, leaving N=848 for the baseline analyses and N=755 for the analyses including follow-up data. ADL disability status (no difficulty, difficulty in ≥1 tasks, or inability in ≥1 tasks) was determined at baseline and the two-year follow-up. The absolute difference between LSA scores at baseline and follow-up were calculated as a measure of change. Median and interquartile range (IQR) of LSA scores and LSA change scores were calculated according to baseline ADL disability status, and for those with or without baseline ADL difficulty also according to two-year follow-up ADL disability status.

Kruskal-Wallis tests were used to assess group differences in baseline LSA scores and change in LSA scores over time according to ADL disability status. Baseline LSA score and change in LSA scores were used to identify participants who developed inability in ≥1 ADL tasks over the follow-up. The highest sum of sensitivity and specificity, corresponding with coordinates of the receiver operator curve (ROC), were calculated. Subsequently, baseline LSA scores and LSA change scores, respectively, were dichotomized based on the cut-off value defined, and participant characteristics were compared in the respective categories with Mann-Whitney U and Chi-square tests. Using multinomial regression analyses, the odds ratios for baseline and follow-up disability status were estimated according to the dichotomized LSA score and LSA change categories. The models were adjusted for factors known to be associated with the development of ADL disability status; age, sex, number of chronic diseases, lower extremity performance, and cognitive function. Analyses were conducted using SPSS (version 20.0; IBM, Armonk, NY, USA) and statistical significance was set at P<.05.

RESULTS

The median age of the participants at baseline was 80.4 (IQR 7.4), and 62% of them were women. Median baseline LSA score was 64 (IQR 30.4) and during the 2-year follow-up the LSA score declined 2 (IQR 22) points. Table 1 shows that at baseline LSA scores decreased with increasing ADL disability, but the change in LSA scores over the two years of follow-up did not differ according to baseline ADL disability status. When accounting for ADL disability status at follow-up, lower baseline LSA scores and larger declines in LSA scores were found among participants who developed *new* ADL difficulty or inability at the follow-up compared to those remaining without difficulty or inability, respectively.

Baseline LSA

The baseline LSA cut-off score of 52.3 rendered the highest sum of sensitivity (0.86) and specificity (0.74) in the ROC curve identifying participants who developed ADL inability over the two-year follow-up (Figure 1a). Table 2 shows that participants with LSA≤52.3 were older, had more chronic conditions, poorer physical performance and poorer cognitive function than those having a higher baseline LSA score. Multinomial regression shows that baseline LSA≤52.3 increased the odds to present baseline ADL difficulty (OR 2.8, 95% confidence interval (CI) 1.8-4.5), but not baseline ADL inability (OR 3.1, 95%CI 0.5-17.8), after adjustment for other factors known to be associated with ADL disability status (Table 3). When participants were additionally grouped based on disability status at follow-up, baseline LSA≤52.3 increased the odds for developing *new* difficulty in ADL among those without difficulty at baseline (OR 2.1, 95% confidence interval (CI) 1.2-3.7) and the odds for developing *new* ADL inability among those with difficulty at baseline (OR 11.5, 95%CI 1.1-126.3), in the fully-adjusted model.

Change in LSA

Based on the ROC curve a LSA decline of >11.7 identified those who developed ADL inability over the two-year follow-up with the highest sum of sensitivity (0.76) and specificity (0.71; Figure 1b). Table 2 shows that participant characteristics of those with a decline in LSA of >11.7 were not different from those experiencing no or smaller declines. Multinomial regression shows that for a LSA decline of >11.7 was associated with *new* ADL difficulty at the follow-up among participants without baseline difficulty, after adjusting for potential confounders (OR 1.9 1.2-3.2;Table 3). In addition, a LSA decline of >11.7 was associated with development of *new* ADL inability among those with ADL difficulty at baseline (OR 8.8, 95%CI 2.0-38.8), in the fully-adjusted model.

DISCUSSION

Based on sensitivity and specificity analyses on the development of ADL inability during the two-year follow-up, we defined LSA≤52.3 as the cut-off value for life-space mobility. This cut-off-point was associated with higher odds to present difficulty or inability in ADL at baseline and with development of *new* difficulty and inability at the follow-up, even after adjustment for factors known to be correlated with development of ADL disability. The current cut-off score is not much different from those found in previous studies with slightly different approaches (LSA 56 and LSA 60).[5,10] As disability in ADL is considered a more advanced form of disability, it is not surprising that the cut-off value we found was slightly lower than those previously found for less severe forms of disability.

Previously, only cross-sectional relationships between LSA and ADL disability have been reported.[2,16,18] In the current study, ADL inability at the follow up coincided with larger declines in LSA over the follow up. Based on the analyses of the current study, a decline in LSA score >11.7 was associated with the development of *new* difficulty and inability in ADL, even after adjustment for potential confounding factors. Previous studies have identified a decline of 10 LSA points as clinically meaningful.[2,12] Changes in life-space mobility over a time period that included hospital admissions were in the range of 9 to 23 points.[25,26] Over a six-month time period that included injurious falls, declines of 5-24 LSA points have been reported depending on injury severity.[27] Such factors may thus play a role in the decline of LSA over time and possibly underlie also the current clinically meaningful decline of >11.7 points. It is important to note that declines in LSA are not necessarily irreversible; Fairhall et al. demonstrated that LSA scores may be improved by multifactorial intervention in participants with some degree of frailty.[28]

This paper is based on a large population-based sample of community-dwelling older people. Unfortunately, more frail older people were under-represented in the sample and those included were somewhat more likely to drop out during the follow-up, which is a common phenomenon in aging research.[29] Sensitivity analyses including participants lost to follow-up due to death or institutionalization in the analyses on ADL disability did not markedly change the results (data not shown). Due to small numbers of people in the ADL inability categories, research results should be interpreted with caution. It is likely that the associations between LSA scores and ADL disability status may have been stronger if more frail people would have been included or retained in the study. However, whether the cut-off points defined are feasible in more frail or clinical populations, that have lower LSA scores in general, needs to be established. We did not account for potential recovery in ADL, which may take place also in people over 75-years-old.[15] Such research requires more frequent assessments of disability status, which were unfortunately not available in the current study.

CONCLUSION

Our results suggest that restrictions and declines in life-space mobility may be early signs of increasing vulnerability for poor health outcomes in community-dwelling older people. Baseline LSA≤52.3 was associated with markedly higher odds to develop *new* difficulty or inability in ADL within two-years. In addition, a LSA decline of >11.7 points over time seems meaningful to community-dwelling older people as it was associated with higher odds to develop *new* difficulty or inability in ADL within two-years. These longitudinally-defined cut-off points may identify community-dwelling older people at risk, which potentially may help in finding clinical applications for the easy to administer LSA assessment tool. Studies with more frequent assessments and longer follow-up periods are warranted to establish patterns of changes in life-space mobility and long-term effects.

ACKNOWLEDGEMENTS

We thank the participants for their time and effort to participate in our study. Gerontology Research Center is a joint effort between the University of Jyväskylä and the University of Tampere. This work was supported by the Academy of Finland (grant number 255403 (Future of Living and Housing – program ASU-LIVE) to [TR], grant number 285747 to [MR]); and the Finnish Ministry of Education and Culture to [TR] and [EP]. The sponsors played no role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

CONFLICT OF INTERREST

No conflict of interest

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FIGURE LABELS

Figure 1. Receiver Operator Curve of a) the Life-Space Mobility (LSA) Score and b) the Change in LSA Score over Time Identifying Participants Who Developed Disability in ADL during the Two-Year Follow-Up (N=733). Area Under the Curve (AUC) and the Optimal Cut-Off Points Are Indicated in the Figures.

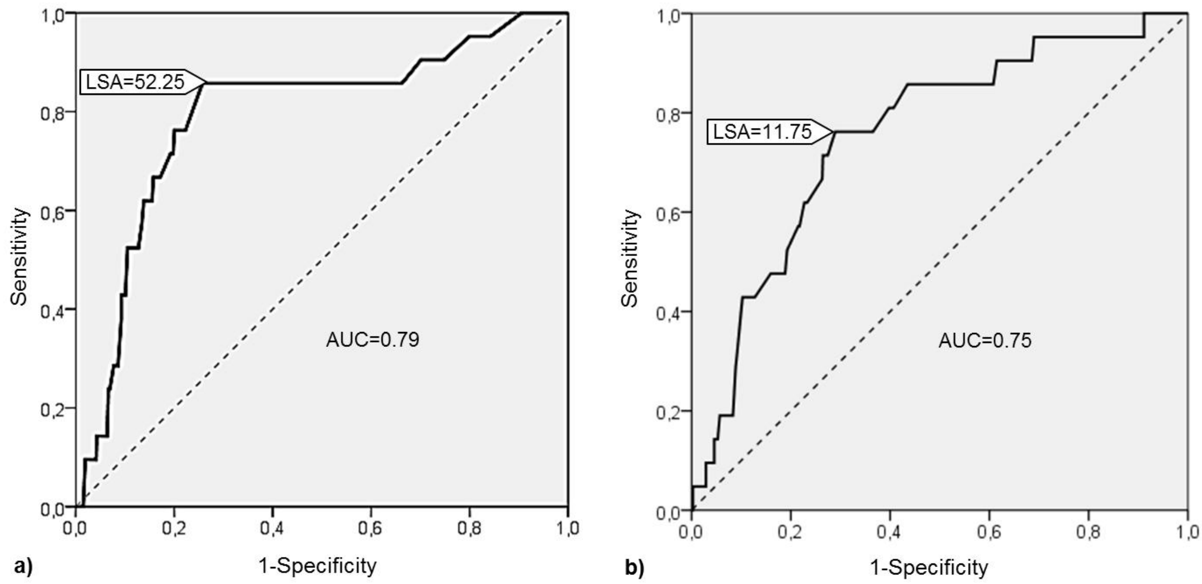

Table 1. Baseline Life-Space Assessment (LSA) Score and LSA Change over Time according to ADL Disability Status at Baseline and the Two-Year Follow-Up.

		Baseline LSA (N=848)						LSA change (N=755)					
ADL Disability Status		**N**	**Median**	**IQR**	**Min.**	**Max.**	**P ***	**N**	**Median**	**IQR**	**Min.**	**Max.**	**P ***
Baseline													
No difficulty		673	68.0	26.5	17.0	120.0	**<.001**	610	-2.0	22.0	-82.0	54.0	.763
Difficulty		159	45.5	28.5	8.0	92.0		132	-3.3	18.3	-58.0	48.0	
Inability		16	30.0	20.4	12.0	62.0		13	2.0	17.8	-24.0	11.0	
Baseline	**Follow-up**												
No difficulty	- No difficulty	524	72.0	24.0	17.0	120.0	**<.001**	524	0.0	22.0	-53.0	54.0	**<.001**
	- Difficulty	82	62.0	27.7	23.0	100.0		81	-9.0	20.0	-82.0	38.0	
	- Inability	5	52.0	44.3	34.0	90.0		5	-30.0	15.8	-37.0	-16.0	
Difficulty	- No difficulty	56	51.5	30.4	19.0	92.0	**.044**	56	0.0	18.4	-28.0	48.0	**.005**
	- Difficulty	60	48.8	22.3	8.0	90.0		60	-2.3	17.4	-58.0	30.0	
	- Inability	16	40.0	12.5	24.0	82.0		16	-14.5	29.5	-53.0	17.5	

IQR = Interquartile range, Min. = Minimum, Max= Maximum

* Kruskal-Wallis test

Table 2. Participant Characteristics in those with Life-Space Assessment (LSA) ≤52.3 vs. >52.3 at Baseline or Decline in LSA ≤11.7 vs. >11.7 over the Two-Year Follow-Up.

	Baseline LSA					**LSA decline**				
	≤52.3 (N=260)		**>52.3** (N=588)			**≤11.7** (N=527)		**>11.7** (N=228)		
	Median	**IQR**	**Median**	**IQR**	**P ***	**Median**	**IQR**	**Median**	**IQR**	**P ***
Age (yr)	82.9	6.5	79.2	6.5	**<.001**	80.0	6.8	80.3	7.8	.207
Number of diseases (n)	5.0	3.0	4.0	3.0	**<.001**	4.0	4.0	4.0	3.0	.314
Short Physical Performance Battery (range 0-12)	9.0	5.0	11.0	3.0	**<.001**	11.0	3.0	10.0	3.0	.093
Mini-Mental State Examination (range 0-30)	26.0	4.0	27.0	3.0	**<.001**	27.0	3.0	27.0	3.0	.199
	%	**N**	**%**	**N**	**P †**	**%**	**N**	**%**	**N**	**P †**
Sex (women)	78.1	203	54.9	323	**<.001**	63.2	333	63.0	145	.970

IQR = interquartile range

* Mann-Whitney U test

† Chi-square tests

Table 3. Odds Ratios (and 95% Confidence Intervals (95%CI)) for Presenting ADL Disability Status at Baseline and at the Two-Year Follow-Up Associated with Baseline LSA Score ≤52.3 or LSA Decline >11.7.

		Baseline LSA						LSA decline					
		≤52.3	>52.3	Model 1 *		Model 2 *[†]		≤11.7	>11.7	Model 1 *		Model 2 *[†]	
ADL Disability Status		**N**	**N**	**OR**	**(95%CI)**	**OR**	**(95%CI)**	**N**	**N**	**OR**	**(95%CI)**	**OR**	**(95%CI)**
Baseline													
No difficulty		**144**	529	1.0		1.0		-	-	-	-	-	-
Difficulty		**102**	57	**6.2**	**4.2-9.3**	**2.8**	**1.8-4.5**	-	-	-	-	-	-
Inability		**14**	2	**18.2**	**3.9-85.2**	3.1	0.5-17.8	-	-	-	-	-	-
Baseline	**Follow-up**												
No difficulty	- No difficulty	**90**	434	1.0		1.0		379	**145**	1.0		1.0	
	- Difficulty	**32**	50	**2.8**	**1.7-4.8**	**2.1**	**1.2-3.7**	47	**34**	**1.8**	**1.1-3.0**	**1.9**	**1.2-3.2**
	- Inability	**3**	2	6.6	.95-45.1	6.0	.8-43.9	0	**5**	-	-	-	-
Difficulty	- No difficulty	**30**	26	1.0		1.0		44	**12**	1.0		1.0	
	- Difficulty	**34**	26	1.2	.6-2.8	1.0	.4-2.6	43	**17**	1.4	0.6-3.3	1.2	0.5-3.0
	- Inability	**15**	1	**27.9**	**3.0-259.3**	**11.5**	**1.1-126.3**	5	**11**	**8.0**	**2.3-27.9**	**8.8**	**2.0-38.8**

* Multinomial regression analyses adjusted for age and sex

† Multinomial regression analyses adjusted for age, sex, number of chronic diseases, Short Physical Performance Battery score, and Mini-Mental State Examination score