Associations between environmental characteristics and life-space mobility in community-dwelling older people

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ABSTRACT

Objectives: To examine the association between perceived environmental barriers to and facilitators for outdoor mobility with life-space among older people.

Methods: Community-dwelling, 75-90-year-old people (n=848) were interviewed face-to-face using standard questionnaires. The Life-Space Assessment (LSA), indicating distance and frequency of moving and assistance needed in moving (range 0-120) was used. Environmental barriers and facilitators outdoors were self-reported.

Results: Altogether, 41% (n=348) of the participants had restricted life-space (LSA score <60). Those reporting one or more environmental barriers had more than double the odds for restricted life-space compared to those reporting no barriers after adjustments for ill health, functioning and socioeconomic differences (SES). Similarly, those reporting four to seven facilitators had lower odds for restricted life-space compared to those reporting three or fewer facilitators.

Discussion: Perceptions of one's environment may either constrain or extend older people's life-space. Longitudinal studies are needed to study the causality of the findings.

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Keywords: Mobility, environment, aging, life-space

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INTRODUCTION

Finding ways to help people to remain active and independent in the community as they age is important. A low frequency of going outdoors is associated with difficulties in mobility (Fujita, Fujiwara, Chaves, Motohashi, & Shinkai, 2006) and the performance of activities of daily living (Kono, Kai, Sakato, & Rubenstein, 2007), while walking outdoors, even as little as two blocks per day, prevents physical decline among older people (Simonsick, Guralnik, Volpato, Balfour, & Fried, 2005). However, it has also been reported that remaining within the confines of one's neighborhood and not venturing to more distant locations may have deteriorating effects on health and functioning (Sawyer & Allman, 2010; Xue, Fried, Glass, Laffan, & Chaves, 2008).

Assessment of life-space mobility is based on the area within which a person moves in her/his daily life, the frequency of travel, and the help needed to accomplish that travel (Baker, Bodner, & Allman, 2003). Reduced frequency of going outdoors and moving only in the close vicinity of home is conceptualized as to restricted life-space (Kono et al., 2007). While life-space mobility correlates with physical activity (Tsai et al, submitted), it also reflects actual community mobility, access to community amenities and participation in society (Sawyer & Allman, 2010; Stalvey, Owsley, Sloane, & Ball, 1999). Restricted life-space is associated with impaired physical performance (Peel et al., 2005; Portegijs, Rantakokko, Mikkola, Viljanen, & Rantanen, 2014), depressive symptoms (Baker et al., 2003), ability to perform activities of daily living (ADL) (Peel et al., 2005; Shimada et al.,

2010), and poor quality of life (Rantakokko, Portegijs, Viljanen, Iwarsson, & Rantanen, 2013), and may lead to cognitive decline (Crowe et al., 2008), home-confinement (Simonsick, Kasper, & Phillips, 1998) and eventually nursing home admission (Sheppard, Sawyer, Ritchie, Allman, & Brown, 2013) or even premature death (Boyle, Buchman, Barnes, James, & Bennett, 2010).

The ecological theory of aging suggests that the behavior of a person is restricted or enhanced by environmental characteristics, depending also on the functional capacity of the individual (Lawton & Nahemow, 1973). It has been shown that environmental features perceived as negative, such as heavy traffic, long distances to services and poor quality streets, are associated with physical inactivity and low level of social participation among older people (Booth, Owen, Bauman, Clavisi, & Leslie, 2000; Dawson, Hillsdon, Boller, & Foster, 2007; Levasseur, Desrosiers, & St-Cyr Tribble, 2008; Richard, Gauvin, Gosselin, & Laforest, 2009; Richard et al., 2013), and may increase the risk for developing walking difficulties (Balfour & Kaplan, 2002; Rantakokko, Iwarsson, Manty, Leinonen, & Rantanen, 2012). Conversely, positive features of the environment, such as the presence of parks and green areas, sidewalks and appealing scenery may stimulate people to move outdoors (Gong, Gallacher, Palmer, & Fone, 2014; Hovbrandt, Fridlund, & Carlsson, 2007) and lower risk the for mobility decline (Eronen, von Bonsdorff, Rantakokko, & Rantanen, 2014).

Knowledge on the association of environmental features with life-space mobility is scarce. One study has shown that the social environment in community destinations such as the attitudes of restaurant staff is associated with life-space (Yang & Sanford, 2012). However, no studies so far have focused on the perceptions of physical mobility barriers and facilitators in the outdoor environment and their association with life-space mobility. The aim of this

study was to investigate the association between perceived environmental barriers to and facilitators for outdoor mobility and life-space among community-dwelling older people.

METHODS

Study design and participants

This study is part of a wider project, "Life-space mobility in old age" (LISPE). The present data are drawn from the project's baseline measurements. The study design and methods have been described in detail elsewhere (Rantanen et al., 2012). Briefly, the target population comprised all community-dwelling 75-to 90-year-old residents of the municipalities of Jyväskylä and Muurame, Finland (N=8914). A random sample of 2,550 people was drawn from the national population register. To be eligible for the study, participants had to be community-dwelling, able to communicate, and willing to participate. After screening, a total of 848 people were interviewed for the baseline data collection in their homes during spring 2012.

The LISPE project was approved by the Ethical Committee of the University of Jyväskylä, Finland. Participants were informed about the project and they signed a written informed consent.

Measurements

Life-space mobility

Life-space mobility was measured with the University of Alabama at Birmingham (UAB) Study of Aging Life-Space Assessment (LSA)(Baker et al., 2003). The LSA captures mobility based on the distance through which a person reports moving during the 4 weeks

preceding the assessment. Questions establish movement patterns according to specific life-space levels, ranging from within one's dwelling to beyond one's town. For each level of life-space (bedroom, home, outside home, neighborhood, town, beyond town), participants were asked how many days within a week they attained that level and whether they needed help from another person or used assistive devices. A life-space mobility score (range 0 to 120), reflecting distance, frequency and independence of movement, was calculated, with higher scores indicating larger life-space. Based on the work by Sawyer and Allman (2010), a score of less than 60 points reflects restricted life-space and indicates that the participant moves generally only within walking distance from his/her home or remains in the neighborhood (Sawyer & Allman, 2010). For the analyses, the life-space mobility variable was dichotomized as "restricted life-space (scores<60)" and "unrestricted life-space" (scores≥60). The reliability of the Finnish life-space assessment scale has been found to be acceptable (Portegijs, Iwarsson, Rantakokko, Viljanen, & Rantanen, 2014).

Perceived environmental barriers to and facilitators for outdoor mobility

Perceived barriers and facilitators in the outdoor environment were assessed using the checklists for perceived environmental barriers (PENBOM; 15 items) and facilitators (PENFOM; 16 items) for outdoor mobility, designed to identify environmental features that people perceive as hindering or facilitating their possibilities for outdoor mobility (Rantanen et al., 2012). The PENBOM includes poor street conditions, high curbs, hills in nearby environment, long distance to services, lack of benches, noisy environment, busy traffic, dangerous crossroads, cyclists on walkways, vehicles on walkways, insecurity due to other pedestrians, poor lighting, lack of sidewalks and snow and ice. The PENFOM comprise the parks, walking routes, nature, appealing landscape, familiar surroundings, good lighting, own yard, other people outdoors motivate, services or shops near, even sidewalks, walkways

without steep hills, resting places by the walking route, peaceful and good quality pedestrian routes, no car traffic, no cyclist on walkways, and safe crossings. The internal consistency of the PENBOM (Cronbach alpha =.716) and the PENFOM (Cronbach alpha =.812) was acceptable. In the analyses, the environmental barriers and facilitators reported by the participants were calculated and then categorized into tertiles. For barriers, the tertiles were zero, one barrier and multiple barriers (two or more) and for facilitators, the tertiles were 0-3, 4-7 and 8 or more facilitators.

Covariates

Walking difficulty was studied with the question "Are you able to walk 500 meters ?" with the following response categories: 1) able without difficulty; 2) able with some difficulty; 3) able with a great deal of difficulty; 4) unable without the help of another person; and 5) unable to manage even with help. For the analyses, walking difficulty was dichotomized into no difficulties (1) and having difficulties (2-5). The number of self-reported, physician-diagnosed, chronic conditions was calculated from a 22-item list and an open-ended question asking about additional chronic conditions (Portegijs et al., 2014). Cognitive functioning was assessed with the Mini-Mental State Examination (MMSE) (Folstein, Folstein, & McHugh, 1975). Socio-economic indicators were self-reports of financial situation (good or very good, moderate, poor or very poor) and years of education. Participants were asked whether they lived alone or with someone else (a spouse, children, grandchildren, siblings or other relatives).

Statistical analyses

Baseline sample characteristics were described using means and standard deviations or percentages. Differences between those reporting restricted/unrestricted life-space were tested with the chi square or t-test. Logistic regression analyses adjusted for age and gender were used to study the associations of each perceived environmental barrier and facilitator with restricted life-space. In addition, logistic regression was used to study the association between the tertiles perceived environmental barriers and facilitators with restricted life-space.

The odds were adjusted, first, for age and sex; second, for walking difficulty; and, third, for number of chronic conditions, perceived financial situation, education in years, cognitive functioning and living alone. When $p<.05$ or the 95% confidence intervals (CIs) did not include 1, the results were regarded as statistically significant. IBM SPSS statistics version 20.0 (SPSS Inc., Chicago, IL) was used for the analyses.

RESULTS

The mean age of the participants was 80.1 years and 62 % of them were women. Almost half (41%, n=348) of the participants had restricted life-space (score <60). Those with restricted life-space were older, had fewer years of education, lower cognitive functioning and more chronic conditions. They were statistically significantly more often women, lived alone, perceived difficulties in walking 500m and perceived their financial situation as moderate or poor compared to those with unrestricted life-space (Table 1).

The most commonly reported environmental barriers to outdoor mobility were snow and ice (53%), hills (24%) and poor street condition (19%). Table 2 shows the age and sex-adjusted associations between perceived environmental barriers and restricted life-space. Nine out of fifteen barriers were associated with restricted life-space, and the strongest association was found between restricted life-space and high curbs, vehicles (such as service vans) on walkways and long distances to services. After additional adjustment for walking difficulties, financial situation, education, cognitive functioning, number of chronic conditions, and living alone, the associations between high curbs (OR 4.0, 95% CI 1.9-8.1), dangerous crossroads (OR 1.9, 95% CI 1.1-3.3), snow and ice (OR 1.4, 95% CI 1.0-2.0) and vehicles on the walkways (OR 4.3, 95% CI 1.1-16.5) with restricted life-space remained statistically significant.

The most common environmental facilitators for outdoor mobility, all of which were reported by more than 60% of the participants, were nature or a lakeside, appealing scenery and familiar surroundings (Table 3). A park or other green area, walking trail/ skiing track, nature, appealing scenery, close proximity to services, good lighting and safe street crossings were associated with unrestricted life-space. After adjustment for walking difficulties, financial situation, education, cognitive functioning, number of chronic conditions, and living alone, a walking trail or skiing track nearby (OR 0.6, 95% CI 0.4-0.9) and nature and/or a lakeside (OR 0.6, 95% CI 0.4-0.9) decreased the odds for restricted life-space.

The mean number of perceived environmental barriers was 1.8±1.9. One-third of the participants (32%) reported no environmental barriers, 21% reported one and 47% reported multiple (two or more). After adjustments for age and sex, those reporting one or multiple environmental barrier had over double the odds for restricted life-space than those reporting

no barriers (Table 4). Walking difficulties explained a substantial part of the association among those who perceived multiple environmental barriers, but the statistical significance remained. Additional adjustments for financial situation, education, cognitive functioning, number of chronic conditions, and living alone did not materially change the associations.

The mean number of perceived environmental facilitators was 6.2±3.6. Those reporting four to seven facilitators were less likely to have restricted life-space than those reporting three or less, even after adjustment for all covariates (Table 4). Parallel association was found between having more than eight facilitators and restricted life-space, but the association was attenuated after adjustment for walking difficulties.

DISCUSSION

Perceived environmental mobility barriers increase and facilitators decrease the odds for restricted life-space among community-dwelling older people.

The novelty of this study is that we studied the associations between environmental barriers and facilitators on life-space among older people, while previous research has mainly focused on individual determinants of life-space. The findings are in line with Clarke and Gallagher (Clarke & Gallagher, 2013), who, in their study of outdoor mobility trajectories among community-dwelling older people, reported that those with more objectively assessed barriers in their environment were more likely to be homebound than those living in accessible environments. Similarly, Hovbrandt and colleagues (2007) reported that people who experience barriers in the outdoor environment start to avoid moving in those areas, whereas positive features of the environment motivate people to go outdoors.

In line with previous studies (Li, Hsu, & Fernie, 2013; Satariano et al., 2010), we found that snow and ice and safety-related aspects such as dangerous crossroads and traffic increased the odds for restricted life-space, while safe street crossings reduced the odds for restricted life-space. We have previously reported that environmental barriers to outdoor mobility contribute to fear of moving outdoors, which is manifested in avoidance of outdoor activities, and increased risk for future mobility limitations (Rantakokko et al., 2009). Other studies have also shown that those who perceive their neighborhood as unsafe are less likely to move outdoors (Satariano et al., 2010).

Physical functioning correlates with life-space mobility, but the correlation is not complete (Portegijs et al., 2014). In the present study, adjusting the associations for walking difficulties attenuated the odds substantially, as people with walking difficulties are more prone to perceive more environmental barriers to outdoor mobility and less likely to report environmental facilitators for outdoor mobility, while they also are more likely to have restricted life-space. However, even after extensive adjustments for ill health, decline in functioning and differences in SES, most of the associations remained significant suggesting that the outdoor environment may influence life-space regardless of one's physical or psychological functioning. This aspect of the findings suggests that environmental barriers may restrict outdoor mobility even among those with intact mobility. Our findings also show that people who report environmental facilitators for outdoor mobility have lower odds for restricted life-space regardless of whether they have walking difficulties or not. Older people who have difficulty walking do not necessarily have restricted life-space, as they have found compensatory strategies that help them to cope with the environment. Older people may prioritize their activities (Hovbrandt et al., 2007) or modify the way of doing tasks, e.g. walk

slower, choose another route (Manty et al., 2007), or use a motor vehicle car or other mode of transportation (Dickerson et al., 2007).

The current findings on environmental facilitators are consistent with previous studies that have shown associations between increased walking activity among older people and parks, walking trails and appealing scenery (Hovbrandt et al., 2007; Rosenberg, Huang, Simonovich & Belza, 2013; Gong et al., 2014;). Possibilities for aesthetic pleasures and an accessible environment motivate people to be active and move around by making walking enjoyable (Rosenberg et al., 2013), thus potentially also decreasing the risk for restricted life-space. An accessible environment may also help people to compensate for their functional limitations and promote neighborhood activity (Stathi et al. 2012). Nevertheless, in the present study, only five out of sixteen of the environmental facilitators were associated with life-space when studied one by one, while the number of facilitators showed a strong association with life-space. Our findings are in line with the previous studies showing that at least four environmental facilitators were needed to yield a positive effect on outdoor activity among older people, while additional facilitators did not further increase the participants' activity level (Sallis et al., 2009; Van Cauwenberg et al., 2013). To what extent facilitators positively affect life-space mobility, also in the presence of concurrent environmental barriers, forms an intriguing area for future research.

Unfortunately, we were not able to identify the precise life-space level where the participant perceived specific environmental barriers and facilitators. The association between environmental characteristics and walking activity may depend on the distance of the facilitators from the home. For example, the presence of sidewalks, benches and a flat walking surface increase walking activity when at a distance of less than 400 meters from

home, but if located further away are no longer associated with walking activity. Aesthetics increase walking activity at distances of from 400 to 1200 meters from home, but not at distances of less or more than these (Etman et al., 2014).

People with fewer amenities within a five-minute walking distance from home make fewer walking trips in their neighborhood (Davis et al., 2011). Short distances to, for example, the grocery store may thus promote walking activity. Longer distances to different amenities may widen the individual's life-space, given the possibility to use some other mode of transportation besides walking, such as driving or taking a bus. The effect of different modes of transportation in relation to perceived environmental features and life-space mobility would be an interesting target for future studies.

The strengths of this study include the broad perspective adopted on the environmental determinants of life-space mobility. By focusing on environmental barriers as well as facilitators we were able to assess factors that increase and decrease the risk for life-space restriction. In addition, we used data collected among a large, population-based sample with very little missing information. We used standardized checklists for environmental barriers to and facilitators for outdoor mobility, developed in our center on the basis of many years of research experience. The study has, however, a few limitations that should be taken into consideration. This design was cross-sectional and thus inferences on causality or the temporal order of events cannot be made. We cannot rule out the possibility that restrictions in life-space may lead to perception of the environment as more challenging than before, while people who move about more in their outdoor environment may report more mobility facilitators. However, in an earlier study we observed that people who went outdoors less often reported fewer environmental barriers than people with comparable disability levels

who went outdoors more often (Tsai et al.2013). We have also shown that perceived barriers in the outdoor environment increase the risk of incident mobility difficulties (Rantakokko et al. 2012).Consequently, it is more likely that environmental mobility barriers lead to life-space restriction rather than the other way round. Nevertheless, it should bear in mind that people with restricted life-space may not have actual experiences of moving around outdoors, and thus might not be able to report accurately on barriers and facilitators. Thus longitudinal studies are needed to confirm the temporal order of events. We categorized the sum of environmental barriers and facilitators according to tertiles but due to distribution of the sample the tertiles were not completely equal in number. We do not think, however, that this would effect on the interpretation of the results. We cannot completely rule out the possibility that the observed associations could stem from residual confounding. We did adjust for mobility limitations and multiple indicators of ill health and SES differences and consider it unlikely that the associations would be entirely explained by these factors. It should also be borne in mind that the present study was conducted in a middle-sized city in central Finland, and thus the results may not be readily comparable with findings for other countries or larger cities. The participants were mainly living in urban residential areas, and no comparison between urban and rural populations was possible. The data were collected during a six month period from January to June. The assessment of life-space mobility is found to be reliable in winter and summer conditions, even though somewhat compromised during winter (Portegijs et al. 2014). Nevertheless, the associations between environmental characteristics and life-space were tested between winter (January-April) and summer (May-June) conditions and no differences in the associations were found. In addition, there were no changes in the proportion of people with restricted life-space between the seasons (*results not shown*). Thus the seasonal change is not likely to underlie the observed results.

Conclusion

Cross-sectionally, environmental mobility barriers increase and facilitators decrease the odds of restricted life-space in old age. To establish whether environmental features predict changes in life-space, however, requires longitudinal studies.

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Table 1. Participant characteristics according to restricted life-space (score <60) among community-dwelling people aged 75-90 years, N=848.

	Restricted life-space		
	Yes	No	
	n=348	n=500	
	Mean ± SD	Mean ± SD	*P**
Age, years	82.4±4.1	79.4±3.9	<.001
Education, years	8.7±3.6	10.2±4.4	<.001
MMSE, score	25.7±3.1	26.5±2.4	<.001
Number of chronic conditions	5.3±2.5	3.7±2.1	<.001
	%	%	
Women	74.9	53.0	<.001
Living alone	66.2	44.6	<.001
Difficulty in walking 500m	46.5	11.2	<.001
Perceived financial situation			<.001
Good or very good	41.3	56.9	
Moderate	54.0	42.5	
Poor or very poor	4.6	0.6	

* P-value, chi square or t-tests

SD, Standard Deviation

MMSE, Mini-Mental State Examination

Table 2. Association between perceived environmental barriers to outdoor mobility and restricted life-space among community-dwelling people aged 75-90 years, N=848.

	Restricted life-space			
Perceived environmental barrier outdoors	Yes n=348	No n=500	OR*	95% CI
	%	%		
Poor street conditions	23.3	15.4	1.5	1.1-2.3
High curbs	14.4	2.6	5.4	2.8-10.7
Hills in nearby environment	32.9	17.2	2.0	1.4-2.8
Long distances to services	17.9	7.6	2.1	1.3-3.3
Lack of benches	22.5	10.8	1.8	1.2-2.8
Lack of benches in winter	24.2	14.8	1.3	0.9-1.9
Noisy environment	4.9	3.0	1.6	0.7-3.4
Busy traffic	11.2	6.2	1.9	1.1-3.2
Dangerous crossroads	12.1	7.0	1.9	1.1-3.1
Cyclists on walkways	20.5	17.8	1.0	0.7-1.5
Snow and ice	63.1	45.8	1.8	1.3-2.4
Insecurity due to other pedestrians	6.6	4.6	1.5	0.8-2.9
Vehicles on walkways	2.9	0.8	4.9	1.4-17.4
Poor lighting	3.7	3.0	1.3	0.6-3.1
Lack of sidewalks	3.7	2.8	1.4	0.6-3.2

* OR, logistic regression analyses, bivariate associations, adjusted for age and sex.

CI, Confidence Interval.

Table 3.Association between perceived environmental facilitators to outdoor mobility and restricted life-space among community-dwelling people aged 75-90 years, N=848.

	Restricted life-space			
Perceived environmental facilitator outdoors	Yes n=348	No n=500	OR*	95% CI
	%	%		
Park or other green area	36.2	43.6	0.7	0.5-0.9
Walking trail, skiing track	43.7	66.8	0.4	0.3-0.6
Nature, lakeside,	63.5	79.0	0.5	0.4-0.8
Familiar environment	62.9	64.0	0.9	0.6-1.2
Appealing scenery	63.8	70.4	0.8	0.5-1.0
Own yard	54.3	59.4	0.8	0.6-1.1
Other people outdoors motivate	18.4	23.0	0.8	0.5-1.2
Good lighting	29.6	43.0	0.6	0.5-0.8
Peaceful and good quality walkways	48.9	51.4	0.9	0.7-1.2
Even sidewalks	30.5	29.2	1.0	0.7-1.4
Resting places by the walking route	21.6	19.4	0.9	0.6-1.3
Walkways without steep hills	12.4	13.4	0.8	0.5-1.2
Services close; shops, market, etc.	40.8	45.8	0.8	0.6-1.0
No car traffic	10.9	14.8	0.8	0.5-1.3
No cyclists on walkways	3.7	5.4	0.8	0.4-1.7
Safe crossings: traffic lights, zebra crossing or traffic island between lanes	19.3	27.3	0.7	0.5-0.9

* OR, Odds Ratio. Logistic regression analyses, bivariate associations, adjusted for age and sex. CI, Confidence Interval.

Table 4. Number of environmental barriers and facilitators associated with restricted life-space among community-dwelling older people, N=848.

		Model 1		Model 2		Model 3	
	n	OR	95% CI	OR	95% CI	OR	95% CI
Barriers							
0	275	1.00		1.00		1.00	
1	177	2.27	1.47-3.51	2.28	1.45-3.60	2.14	1.34-3.43
2 ≥	396	2.58	1.79-3.71	2.11	1.43-3.10	1.85	1.24-2.78
Facilitators							
0-3	223	1.00		1.00		1.00	
4-7	338	0.52	0.36-0.76	0.61	0.41-0.91	0.64	0.42-0.96
≥8	286	0.51	0.35-0.76	0.67	0.44-1.02	0.71	0.46-1.10

Model 1: adjusted for age and sex

Model 2: adjusted for age, sex and difficulty in walking 500m

Model 3: adjusted for age, sex, difficulty in walking 500m, living alone, perceived financial situation, education in years, number of chronic conditions and cognitive functioning