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Year: 2016

Version:

Please cite the original version:

Viljanen, A., Mikkola, T., Rantakokko, M., Portegijs, E., & Rantanen, T. (2016). The Association Between Transportation and Life-Space Mobility in Community-Dwelling Older People With or Without Walking Difficulties. Journal of Aging and Health, 28(6), 1038-1054. https://doi.org/10.1177/0898264315618919

The Association between Transportation and Life-space Mobility in Community Dwelling Older People With or Without Walking Difficulties

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Running title: Transportation and life-space mobility

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Abstract

Objectives: To examine whether a persons' most frequently used mode of transportation is associated with life-space mobility, and whether the association differs between persons with or without walking difficulties. Methods: Life-space mobility was measured with the Life-Space Assessment in 848 community-dwelling men and women aged 75-90 years. Six separate mobility groups were formed according to the most frequently used mode of transportation (car driver, car passenger, public transportation) combined with the presence or absence of difficulties walking 2 km. Results: Car drivers without walking difficulties had the highest life-space mobility scores and car passengers with walking difficulties had the lowest scores. Mode of transportation influenced the odds for restricted life-space differently depending on whether or not the person had walking difficulties. Discussion: To support community mobility among older persons, it would be important to improve different transportation options to meet older persons´ individual wishes, needs and resources.

Keywords: Aging, Life-space, Mobility, Transportation, Walking

The Association between Transportation and Life-space Mobility in Community Dwelling Older People With or Without Walking Difficulties

The ability to go where, when and how one wants is an important component of quality of life among older people and one of the cornerstones of their ability to live actively and independently in the community (Rantakokko, Portegijs, Viljanen, Iwarsson, & Rantanen, 2013; Satariano et al., 2012). Driving and walking are the two most frequent modes of mobility, and the longer the distance to travel, the more dependent a person is on using a car or other modes of transportation (Collia, Sharp, & Giesbrecht, 2003). Driving a car or having easy access to transportation services may be essential for independent living, particularly if a person's walking capacity has declined or desired amenities are located beyond walking distance.

Life-space mobility is a concept which describes the size of the spatial area a person moves through in daily life, the frequency of travel in different life-space areas and the need of assistance for travel in those areas (Baker, Bodner, & Allman, 2003). Life-space mobility reflects the balance between a person's internal physiologic capacity and the environment, which may either support or restrict a person's mobility, and consequently participation in society. Restricted life-space mobility is associated with decline in physical performance and functioning (Al Snih et al., 2012; Baker et al., 2003; Barnes et al., 2007; Peel et al., 2005; Portegijs, Rantakokko, Mikkola, Viljanen, & Rantanen, 2014), depressive mood (Polku et al. 2014), cognitive decline (Crowe et al., 2008), poorer quality of life (Rantakokko et al., 2013) and mortality (Boyle, Buchman, Barnes, James, & Bennett, 2010).

The association between transportation and life-space mobility has been studied to some extent, but studies have concentrated either on self-perceived transportation options, not

the actual usage, or specifically on driving. Unmet needs for transportation (Murata, Kondo, Tamakoshi, Yatsuya, & Toyoshima, 2006) or difficulties in getting transportation (Peel et al., 2005) often co-occur with restricted life-space mobility, whereas driving a car is associated with larger life-space (Shah et al., 2012; Stalvey, Owsley, Sloane, & Ball, 1999). Driving cessation, in turn, is associated with low out-of-home activity levels, even after adjustment for sociodemographic and health-related factors (Marottoli et al., 2000).

There is a clear gap in the current knowledge how the use of different transportation modes influences life-space mobility among older persons, and particularly whether transportation mode has a different effect on life-space mobility among persons with or without walking difficulties. It can be assumed that particularly if a person's walking capacity is limited he or she may be more dependent on a suitable transport option to ensure his or her active community mobility. This study contributes a new insight to the current literature on the community mobility of older men and women by focusing on the actual use of different modes of transportation (car driver, car passenger, public transport, taxi) in the presence or absence of walking difficulties. The aim of this study was to investigate whether the most frequently used mode of transportation is associated with life-space mobility, particularly with the independent life-space area, in community-dwelling older people, and whether the possible association differs between men and women with or without walking difficulties. The specific research questions were: Is the most frequently used mode of transportation associated with life-space restriction? Does the possible association between transportation and life-space restriction differ between persons with or without walking difficulties? Is the possible association between transportation, walking and life-space gender-specific?

Method

Study Design and Recruitment

The present data are drawn from the baseline measurements of the prospective "Life-space mobility in old age" (LISPE) cohort study in community-dwelling older men and women. The study design, methods and non-response analyses have been described in detail earlier (Rantanen et al., 2012). Briefly, a random sample of 2 550 persons, aged 75 to 90 years, and living in the municipalities of Jyväskylä and Muurame in central Finland was drawn from the population register. Persons were informed about the study and their eligibility for the participation was screened via telephone interview. The inclusion criteria were: willingness to participate, resident in the recruitment area, and able to communicate. A total of 848 persons met the inclusion criteria. The study included a structured face-to-face home interview by trained interviewers. Computer-assisted personal interviewing -technique was utilized in data collection. The LISPE-study includes extensive data about several aspects of participants´ health, physical functioning, social participation and living environment (see in details Rantanen et al., 2012).

The LISPE project was approved by the ethical committee of the University of Jyväskylä, Finland. All the participants signed an informed consent at the start of the home interview.

Measurements

Outcome

Life-space mobility, was assessed using the 15-item University of Alabama at Birmingham Study of Aging Life-Space Assessment (LSA) (Baker et al., 2003). The LSA assesses mobility through the different life-space levels (bedroom, other rooms, outside home, neighborhood,

town, beyond town) during the preceding four weeks reflecting persons´ actual mobility performance in daily life. For each life-space level, participants were asked how many days a week they attained the level, and whether or not they needed the help of assistive devices or other persons. In this study, we utilized two indicators of life-space mobility: 1) Independent life-space, describing the highest level of life-space attained without help from assistive devices or other persons, and dichotomized into "restricted life-space", which includes the levels from bedroom to neighborhood, and "unrestricted life-space", which includes the levels beyond neighborhood; and 2) the Life-space mobility score, which reflects the distance, frequency and level of independence (range 0-120; higher scores indicate better life-space mobility). The reliability of the LSA has been found to be acceptable (Baker et al., 2003; Peel et al., 2005; Portegijs, Iwarsson, Rantakokko, Viljanen, & Rantanen, 2014).

Explanatory variables

The frequency of use of different, the most common modes of transportation was assessed by four questions. Participants were asked how often they drive a car, travel by a car as a passenger, use public transportation such as a bus or a train, and use a taxi or Special Transportation Services. Response options were: daily or almost daily, a few times a week, a few times a month, a few times a year, less than once a year, and never. Accordingly, the main mode of transportation was defined as the most often, at least monthly used, transportation mode. If several modes were used equally often, the informant's main mode of transportation was ordered as follows: car driver, public transportation, car passenger, taxi.

Perceived difficulty in walking 2 km was assessed with the following response options: able without difficulty, able with some difficulty, able with a great deal of difficulty,

unable without the help of another person, and unable to manage even with help. In the analyses, the categories were dichotomized into “no walking difficulties” and “walking difficulties”, which includes all the other responses.

Covariates

Participants’ age and gender were derived from the national register. The number of self-reported, physician-diagnosed chronic diseases was calculated from a list of 22 chronic diseases and an additional open-ended question about any other physician diagnosed chronic conditions. These responses were reviewed by a physician. Depressive symptoms were assessed with the 20-item Centre for Epidemiologic Studies Depression Scale (CES-D, range 0-60, a higher score indicating more depressive symptoms) (Radloff, 1977). Cognition was assessed with the 30-item Mini-Mental State Examination (MMSE, range 0-30, a higher score indicating better cognitive functioning) (Folstein, Folstein, & McHugh, 1975). The participants’ living situation and socioeconomic status was assessed by asking whether they live alone or with someone else (with a spouse; with children or grandchildren; with siblings, relatives or others), how they rate their financial situation (response options were dichotomized into 1) very good or good, and 2) average, poor or very poor) and total number of years of education attended.

Statistical analyses

Characteristics of the participants are described using means and standard deviations (SD) or percentages. Chi-square tests for categorical variables and t-tests for continuous variables were used to analyze whether the characteristics of the participants differed according to gender or life-space restriction. Univariate logistic regression models were performed to analyze whether

the restricted life-space was associated with the mode of transportation, walking difficulties and other covariates, and a multivariate logistic regression model was performed to assess the effects of covariates on the association.

Analysis of variance (ANOVA) was used to compare the means of the life-space composite scores in the separate mobility groups. The Bonferroni post-hoc test was utilized in the sub-group analyses, in the case of groups with equal variances, and Tamhane´s T2 test was utilized in the case of unequal variances. Furthermore, ANOVA was used to study the possible interaction between mode of transportation and walking difficulties for life-space mobility score. To assess the combined effect of transportation mode and 2 km walking difficulties in more detail, six separate mobility groups were formed: car drivers, car passengers (either private car, taxi or Special Transportation Services), public transportation users, and each of these with or without walking difficulties. Univariate logistic regression model was performed to analyze whether the restricted life-space was associated with mobility group, and a multivariate logistic regression model was performed to assess the effects of covariates on the association.

Separate analyses were conducted for men and women, as the life-space composite score, main transportation mode and prevalence of walking difficulties differed according to gender (all p-values <.000), and because the gender-transportation interaction term was statistically significant for the life-space composite score (p=.037).

The modeling was performed using IBM SPSS statistics version 20.0 (SPSS Inc., Chicago, IL).

Results

Altogether, 62% of the participants were women and the mean age of the participants was 80.6 ± SD 4.3 years. The mean life-space mobility score was 71.1 ± 20.2 for

men and 59.5 ± 19.6 for women (p<.001), and life-space was restricted to the neighborhood level for 18% of men and 35% of women (p<.001). The most prevalent mode of transportation in men was car driving (76%), whereas in women it was being a passenger in a private car (44%), followed by use of public transportation (30%) and car driving (18%). At least some difficulties in walking 2 km were reported by 33% of men and 48% of women (p<.001). Participants who had restricted life-space were older, reported more chronic diseases, had more depressive symptoms, poorer cognition, poorer financial situation, and lived alone more often than those with unrestricted life-space. Characteristics of the participants according to gender and life-space restriction are presented in Table 1.

The 44 (5%) participants who did not report using any mode of transportation at least monthly were excluded from the subsequent analyses. Their mean life-space score was 51.5 ± 18.4, and 45% of them reported walking difficulties.

Among men, the mean life-space composite score was 76.2 ± 16.9 for car drivers, 49.6 ± 21.8 for passengers (private car or taxi), and 65.5 ± 17.2 for persons whose main mode of transportation was public transportation (ANOVA, p<.001, Bonferroni post-hoc comparisons: driver-passenger p<.001, driver-public transportation p=.007). In women, the corresponding mean scores were 72.0 ± 16.5, 54.6 ± 20.3, and 62.9 ± 15.9 (ANOVA, p<.001, Tamhane post-hoc comparisons: driver-passenger p<.001, driver-public transportation p<.001). Men who were car passengers had almost seventeen times higher odds (OR 16.96, 95% CI 8.10-35.50) for restricted life-space compared to men who were car drivers. After adjustment of the model for walking difficulties, age, perceived financial situation, living situation, number of chronic diseases, cognitive functioning and depressive symptoms, the OR was seven-fold (OR 7.24 95% CI 3.07-17.11). Among women, the corresponding, adjusted OR was 3.21 (95% CI 1.47-7.02).

When compared to car drivers, the likelihood for restricted life-space did not differ among men or women whose main mode of transportation was public transportation. (Table 2.)

A statistically significant interaction between mode of transportation and walking difficulties for life-space mobility score was observed in women [ANOVA, $F(2)=6.790$, $p=.001$], but not in men [ANOVA, $F(2)=0.636$, $p=.530$]. To gain a more detailed idea of the interaction between mode of transportation and walking difficulties as correlates of life-space restriction, six separate mobility groups were formed based on the combined distribution of difficulties in walking 2 km (yes/no) and the main mode of transportation (car driver, car passenger, or public transportation) (Figure 1). Both in men and women, the highest life-space mobility score was observed in the sub-group of car drivers without walking difficulties, and the lowest score was observed in the sub-group of car passengers with walking difficulties. Among men, compared to car drivers without walking difficulties all the other sub-groups, except that of public transportation users without walking difficulties ($p=.498$), had statistically significantly ($p<.001$) lower life-space mobility scores. Similarly, among women, the only sub-group that did not differ from the reference group was that of car passengers without walking difficulties ($p=.061$). (Figure 1.)

Among women without walking difficulties the adjusted odds for restricted life-space did not differ between car drivers, car passengers and public transportation users, while among those with walking difficulties the odds for restricted life-space was highest in car passengers followed by public transportation users, and lowest in car drivers. The same was true for men, with the exception that, even in the absence of walking difficulties, being a car passenger increased the odds for restricted life-space. (Table 3.)

Discussion

This study contributes a new insight to the literature on the community mobility of older men and women by focusing on the actual use of different modes of transportation in the presence or absence of walking difficulties. The main findings of this study are, first, that mode of transportation is associated with life-space restriction, and second, that the association differs depending on whether or not the person has walking difficulties. Furthermore, this study indicates that the association between transportation, walking and life-space is gender-specific. In general, in the absence of walking difficulties, mode of transportation did not affect life-space mobility as much as it did in the presence of walking difficulties. Car drivers without walking difficulties had the highest life-space mobility scores, while the lowest scores were observed among car passengers with walking difficulties.

In this study, among women without walking difficulties, the odds for restricted life-space did not differ between car drivers, passengers and public transportation users, while among those with walking difficulties life-space restriction was most prevalent among car passengers, followed by public transportation users and lowest in car drivers. The same was true for men, except that even in the absence of walking difficulties, being a car passenger increased the odds for restricted life-space. The results of this study are in line with previous findings that have shown an associated between driving a car and wider life-space or more active participation in social activities outside the home (Marottoli et al., 2000; Murata et al., 2006; Peel et al., 2005; Shah et al., 2012; Wilkie, Peat, Thomas, & Croft, 2007). According to Shah et al. (Shah et al., 2012), persons who were licensed to drive were less likely restrict their life-space over the average four-year follow-up, compared to persons without a driver´s license. Previous studies have also shown that persons who report difficulty getting transportation have restricted mobility

outside the home (Murata et al., 2006; Peel et al., 2005; Wilkie et al., 2007), and furthermore, that unmet transportation needs are reported more often by those with at least one difficulty in activities of daily living (ADL) compared to those without ADL difficulties (Murata et al., 2006). Wilkie et al. (Wilkie et al., 2007) studied the combined effect of walking difficulties and access to a car or public transportation on restricted mobility outside the home among older persons with knee pain. According to their results, having no access to public transportation or having no access to a car was associated with mobility restriction, and even more so among persons who reported walking difficulties combined with no access to transportation. However, their results also suggest that some persons with walking limitations are capable of maintaining active out-of-home mobility, if they have access to public transportation or a car.

A clear difference in transportation usage between men and women, and between older and younger persons has been reported previously (Collia et al., 2003; Fristedt, Dahl, Wretstrand, Bjorklund & Falkmer, 2014). In the present study, three-quarters of the men were active car drivers compared to less than a fifth of the women. These figures are in line with the Finnish National Travel Survey (*National travel survey 2010-2011,* 2012), but lower than reported, for example, in the USA (Collia et al., 2003). The most commonly reported mode of transportation in women was being a car passenger. In Finland, in the oldest age groups, men more typically have a driver's license than women. In the future, this will most probably change as in the younger generations ownership of a driver´s license is approximately equally common among women as men (*National travel survey 2010-2011,* 2012). There is also some evidence that men are more likely to renew their driver´s license in old age than women, although it has been shown that renewal is more dependent on the more active driving habits of older men than on gender per se (Hakamies-Blomqvist & Siren, 2003). In Finland, all drivers have to renew their license at

the age of 70 years at the latest, and every fifth year after that. The renewal process includes a medical examination. In the future, it would be interesting to study how driving cessation influences life-space mobility, and, if so, whether or not such influences differ according to gender.

In addition to ownership of a drivers´ license, the poorer financial situation of women and their tendency to live alone in old age more often than men are associated with the opportunity for using different transportation options, and consequently with life-space restriction. An interaction between walking difficulties and the main mode of transportation used for life-space mobility was observed among women but not men. A sizeable proportion of women car passengers without walking difficulties had high life-space mobility. These women most probably lived with another person, most often with their husband, and could rely on the possibility of getting a lift when needed. An interesting detail was that, among this sub-group of women car passengers without walking difficulties, almost every woman who lived with another person (96%) had unrestricted life-space, compared to 74% of those who lived alone. On the other hand, the sub-group of female passengers with severe walking difficulties, and who were reliant on the help of the other persons because of their poor health had diminished life-space. Among men, the association between mode of transportation and walking difficulties seems to be more straightforward, with the lowest life-space mobility scores occurring among men with walking difficulties and who were dependent on getting rides from other persons.

Results of this study showed that participants' age, perceived financial situation, living situation, number of chronic disease, cognition and depressive symptoms decreased the likelihood for restricted life-space in all separate mobility groups, indicating that a part of the association between transportation, walking and life-space restriction is explained by above

mentioned covariates. For example male car drivers with walking difficulties had approximately six-fold higher likelihood for restricted life-space compared to drivers without walking difficulties. The adjustment decreased the likelihood markedly, but still, car drivers with walking difficulties had approximately four-fold likelihood for restricted life-space.

This study has several strengths. First, it contributes a new, more comprehensive insight to current knowledge on older persons' community mobility, as it takes into account both the mode of transportation actually used by older people and their walking capacity. The modes of transportation studied were various, including public transportation and taxis, in contrast to previous studies on transportation and life-space mobility having a driver's license vs. not having driver's license has been the only point of comparison (Shah et al., 2012). Second, this study is based on a large population-based sample of community dwelling older people with little missing data. The study sample includes persons up to the age of 90 years, for whom previous research knowledge is rather limited.

However, the study has some limitations that should be taken into account when interpreting the results. The number of the participants in some of the separate mobility groups was limited, and consequently those results need to be interpreted with a caution. It should also be noted that the life-space mobility score describes mobility during the previous four weeks, and hence a single trip beyond neighborhood during that period could substantially influence the total life-space mobility score. Moreover, because the life-space questionnaire assesses mobility during the previous month, only the modes of transportation used at least monthly were taken into account in the analyses. Five percent of the participants did not report using any transportation mode at least monthly. Since their life-space mobility score was comparable to that of the car passengers, and half of them reported walking difficulties and half did not, we do

not believe that their exclusion from the analyses has materially biased the results. It is, however, possible that the questionnaire used in this study did not capture all possible modes of transportation including, for example, bicycles and mopeds. We have previously reported a somewhat higher life-space mobility score in spring time (no snow in the ground) than in winter (Portegijs et al., 2014), and it is possible that weather conditions may also influence the use of different modes of transportation (Weeks, Stadnyk, Begley, & MacDonald, 2013). Follow-up studies are needed to determine whether people change their main mode of transportation according to the season and, if so, how this affects life-space mobility among older people. In this study, no association between residential area and life-space mobility was observed; this is plausible in the present instance due to the low number (6%) of participants living in rural areas. This should be taken into account when generalizing the findings. Further studies are needed to better understand the possible influences that different transportation options may have on life-space mobility in urban and rural areas. Furthermore, longitudinal studies are needed to confirm the temporal order of events and to investigate the causal relationships.

Conclusion

Our results suggest that for older persons driving one´s private car is important for maintenance of larger life-space, and of especially importance for persons who have walking difficulties. To support community mobility among older persons, it would be important to improve different transportation options to meet older persons´ individual wishes, needs and resources, and so also ensure the active and independent involvement in society of older people with disabilities.

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Table 1

Characteristics According to Gender and Life-space Restriction.

	Men		Women			Unrestricted life-space		Restricted life-space		
	n=322		n=526		t-test	n=606		n=242		t-test
Characteristic	mean	±SD	mean	±SD	p	mean	±SD	mean	±SD	p
Life-space mobility score (p)	71.1	20.2	59.5	19.6	<.001	73.3	15.1	40.6	12.1	<.001
Age (yrs)	80.1	4.1	80.9	4.3	.003	79.7	4.0	82.8	4.1	<.001
Chronic diseases (n)	4.0	2.2	4.6	2.5	<.001	3.9	2.2	5.6	2.6	<.001
Education (yrs)	10.3	4.7	9.2	3.7	<.001	9.9	4.2	8.8	3.9	.001
CES-D (p)	8.3	6.0	10.5	7.2	<.001	8.6	6.2	12.3	7.49	<.001
MMSE (p)	26.2	2.8	26.1	2.8	.791	26.4	2.6	25.5	3.2	<.001
	n	%	n	%	χ^2-test	n	%	n	%	χ^2-test
Main transportation mode										
Car driver	242	75.2	88	16.7	<.001	296	48.8	34	14.0	<.001
Car passenger	35	10.9	216	41.1		138	22.8	113	46.7	
Public transportation	29	9.0	145	27.6		139	22.9	35	14.5	
Taxi	12	3.7	37	7.0		13	2.1	36	14.9	
No mode[a]	4	1.2	40	7.6		20	3.3	24	9.9	
Difficulty 2 km walking										
Yes	105	32.6	251	47.7	<.001	160	26.4	196	81.0	<.001
Average, poor or very poor financial situation										
Yes	141	44.1	278	52.9	.016	280	46.3	139	57.7	.003
Live alone										
Yes	85	26.4	367	69.9	<.001	284	46.9	168	69.7	<.001

[a] Participant did not report use, at least monthly, of any of the transportation modes listed: car driver, passenger in private car, use of public transportation or use of a taxi

CES-D Centre for Epidemiologic Studies Depression Scale

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Table 2

Odds Ratios (OR) for Restricted Life-space.

	MEN				WOMEN			
	Univariate models		Multivariate model		Univariate models		Multivariate model	
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Transportation used								
Car driver	1		1		1		1	
Car passenger	16.96	8.10-35.50	7.24	3.07-17.11	5.21	2.75-9.86	3.21	1.47-7.02
Public transportation	2.19	0.76-6.34	1.35	0.41-4.44	1.51	0.74-3.07	1.06	0.46-2.44
2 km walking difficulties								
No difficulties	1		1		1		1	
Difficulties	7.24	3.85-13.63	4.15	1.90-9.05	13.93	8.78-22.10	8.39	4.85-14.53
Financial situation								
Good or very good	1		1		1		1	
Average, poor or very poor	1.23	0.69-2.18	0.88	0.41-1.88	1.62	1.12-2.33	1.08	0.65-1.79
Living situation								
Live with others	1		1		1		1	
Live alone	1.83	1.00-3.36	1.14	0.50-2.58	2.19	1.43-3.34	1.74	0.96-3.17
Age	1.24	1.15-1.34	1.10	1.00-1.21	1.18	1.13-1.24	1.09	1.02-1.16
Number of chronic diseases	1.31	1.15-1.49	1.16	0.97-1.38	1.32	1.22-1.43	1.18	1.05-1.31
CES-D score	1.07	1.02-1.12	1.03	0.97-1.09	1.08	1.05-1.11	1.04	1.00-1.08
MMSE score	0.83	0.76-0.91	0.90	0.79-1.02	0.91	0.86-0.97	0.97	0.89-1.06

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Table 3

Odds Ratios (OR) for Restricted Life-space in Separate Mobility Groups.

	MEN				WOMEN			
	Univariate model		Multivariate model[a]		Univariate model		Multivariate model[a]	
Mobility groups	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI
Car driver								
No walking difficulties	1		1		1		1	
Walking difficulties	5.56	2.18-14.16	3.61	1.33-9.78	7.12	1.96-25.92	4.05	1.06-15.47
Car passenger								
No walking difficulties	15.55	4.90-49.30	6.46	1.72-24.26	1.99	0.62-6.41	1.67	0.50-5.58
Walking difficulties	64.13	21.11-194.78	28.35	8.56-93.85	38.12	12.99-111.90	18.44	5.98-56.82
Public transportation								
No walking difficulties	1.34	0.16-11.37	0.84	0.09-7.41	1.20	0.34-4.30	0.74	0.20-2.83
Walking difficulties	10.69	2.65-43.08	6.31	1.35-29.55	10.24	3.25-32.24	5.23	1.59-17.24

[a] Adjusted for age, perceived financial situation, living situation, number of chronic diseases, MMSE score, and CES-D score.

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MMSE Mini-Mental State Examination

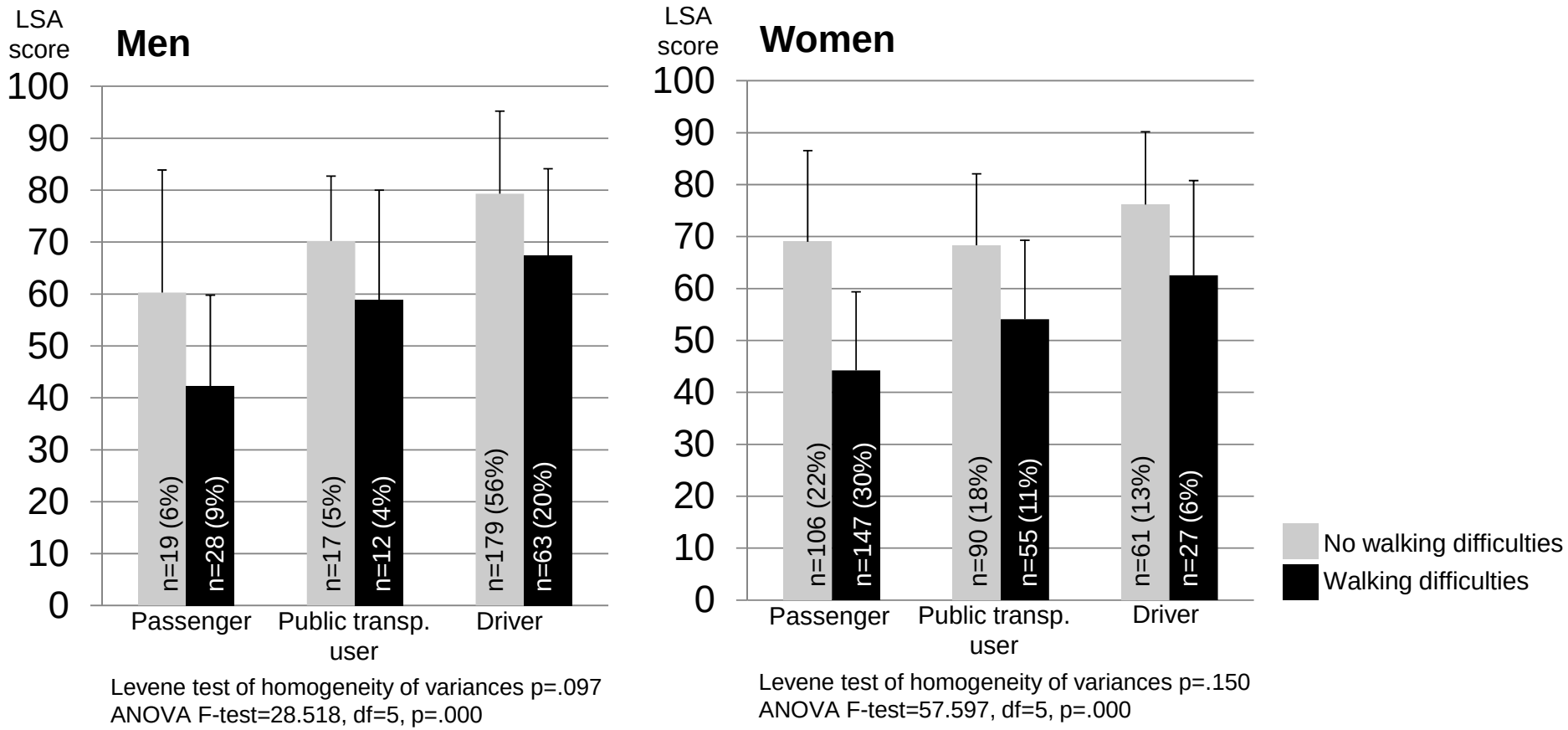

Figure 1. Mean Life-space Mobility (LSA) Scores and Standard Deviations According to Transportation Used and Difficulties Walking 2 km in Men and Women