doi: 10.2490/prm.20220023 Progress in Rehabilitation Medicine 2022; Vol. 7, 20220023

ORIGINAL ARTICLE

Gender Differences in Life-space Mobility-associated Factors and Structures in Community-dwelling Older People

Kensuke Matsuda, PhD [a] Takashi Ariie, MS [a] Ryota Okoba, PhD [a] Nozomi Hamachi, PhD [a] Akari Suzuki, PhD [a] Hideo Kaneko, PhD [a] and Masaharu Morita, PhD [b]

Objectives: This cross-sectional study sought to examine gender dissimilarities in factors and structures associated with life-space mobility (LSM) in community-dwelling older people. **Methods:** This study included a total of 294 older people living in Okawa, Fukuoka Prefecture, Japan. The subjects' body mass index (BMI) and skeletal muscle mass index (SMI) were evaluated. Furthermore, the age, gender, and LSM of the participants were assessed. LSM was assessed using a framework based on social isolation, fall self-efficacy, mobility, cognitive function, and lower limb muscle strength. Path analysis was performed to assess LSM-associated factors and their respective effect sizes (ESs), and male and female LSM models were established. **Results:** Path analysis identified SMI and social isolation as direct factors and cognitive function as an indirect factor associated with LSM in both men and women. In the male LSM model, the direct factors in descending order of ES were BMI, social isolation, SMI, and lower limb muscle strength. In the female model, the direct factors in descending order of ES were age, fall self-efficacy, mobility, social isolation, and SMI; age was noted as having an indirect effect on the remaining associated factors. **Conclusions:** This study clarified the gender differences in factors influencing LSM and the underlying structure of LSM mediation by these factors. Therefore, gender differences should be considered when planning interventions aimed at improving the LSM and general well-being of older people, particularly for community-dwelling individuals.

Key Words: aging; cognitive function; social network; fall self-efficacy; sex factors

INTRODUCTION

The life space is the physical and social environment in which people live and function in their daily life. Life-space mobility (LSM) reflects the extent to which people move in the community, need assistance in doing so, use community amenities, maintain social relationships and roles, and participate in meaningful activities.[1] LSM considerably affects the quality of life of older people.[2] Because both the living space and mobility of older people decrease as their physical and mental functions decline, a theoretical framework to identify and hierarchize the factors that affect LSM would appear to be essential.

Considering the importance of LSM in the context of older peoples' living space, Kaufmann et al. developed a framework based on the factors related to motivation for mobility and environment and subdivided them into categories such as access, skills, and appropriateness.[3] Access includes older people's access to infrastructures, services, and facilities and services; physical and cognitive skills include driving a car and other relevant skills; and psychosocial factors include planning, personal needs, values, and motivations.[3] Regarding the relationship between the abovementioned categories[3] and life space, the factors in the "appropriateness"

Received: February 21, 2022, Accepted: April 11, 2022, Published online: May 12, 2022
[a] Department of Physical Therapy, School of Health Sciences at Fukuoka, International University of Health and Welfare, Fukuoka, Japan
[b] Department of Physical Therapy, School of Health Sciences at Odawara, International University of Health and Welfare, Kanagawa, Japan
Correspondence: Kensuke Matsuda, PhD, Department of Physical Therapy, School of Health Sciences at Fukuoka, International University of Health and Welfare, 137–1 Enokizu, Okawa City, Fukuoka 831-8501, Japan, Email: k.matsuda@iuhw.ac.jp
Copyright © 2022 The Japanese Association of Rehabilitation Medicine
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial No Derivatives (CC BY-NC-ND) 4.0 License. http://creativecommons.org/licenses/by-nc-nd/4.0/

category are reportedly the strongest, followed by those in the "skills" category.[4] LSM in older people depends on the fear of falling,[5] cognitive decline,[6] and the sequels of falls and fractures.[7] Reduced LSM in older people is promoted by a smaller life space, for instance, being homebound, thereby increasing the risk of serious illnesses[8] and rates of hospitalization and mortality[9]; this translates into increased healthcare costs for this age group.

Recent studies on narrowed life space have focused on disparities in the life space and mobility that result from gender and race differences. For instance, black people tend to have inferior life spaces over time than white people[10]; this tendency is prominent in older women as they have decreased life spaces because their activities are limited to their neighborhood.[11] Furthermore, during their post-reproductive life, the LSM of women is influenced by age marginalization and expected gender roles[12] and differences with men in terms of domestic tasks and social roles.[13] Therefore, LSM appears to be a crucial assessment factor for improving the well-being of community-dwelling older people[14]; LSM is also a comprehensive measure of resilience against physical and social isolation in the later period of life.[15] Taken together, the aforementioned evidence demonstrates that disparities in decreased life space and LSM vary across older people based on gender and disrupt their quality of life. Therefore, knowledge regarding the gender dissimilarities in the structures restricting LSM is essential for developing interventions to enhance the health and functionality of older people, particularly women.

The LSM of older people appears to highly relate to the abovementioned factors in the "appropriateness" and "skills" categories; there is a gender-based unevenness in life space and mobility among older people. However, to the best of our knowledge, concrete differences among factors associated with LSM and the relevance of gender differences in older people remain to be clarified. A structural analysis of the life space of older people has been reported[16]; however, that study did not include any assessment of the sociality of older people or gender differences. Consequently, the current cross-sectional examination aimed to determine the gender differences in LSM-related factors and, through path analysis, the corresponding structure of influence in older people.

MATERIALS AND METHODS

Study Design

This was a cross-sectional study involving path analysis.

Participants

The data used in the present cross-sectional study were taken from an elderly physical fitness measurement project. This project started in 2015 to check the health condition of community-dwelling people aged 65 years or older. Several reports have been published,[16,17] and we used the data newly obtained in 2018. The current study included a total of 294 community-dwelling participants aged ≥65 (mean age, 78.0 ± 5.4) years (106 men and 188 women). The inclusion criteria were as follows: age ≥65 years and resident in Okawa, Fukuoka Prefecture, Japan. The only exclusion criterion was having missing data (five participants).

Assessment

Data regarding the age and gender of our participants were collected. For all participants, we measured height, weight, body mass index (BMI), and muscle mass. BMI and muscle mass were measured with an InBody 270 composition analyzer (InBody270, Biospace, Cerritos, CA, USA), using bioelectrical impedance analysis (BIA). Muscle mass was calculated by subtracting the mass of fat and bone from the body weight because it has been reported that muscle mass obtained using the BIA method highly correlates with the values obtained through dual-energy X-ray absorptiometry.[18] Using the InBody 270, we assessed skeletal muscle mass on the basis of the water content of each body part by applying three frequencies of alternating current (5, 50, and 500 kHz) to the distal extremities. A decrease in skeletal muscle mass with age often leads to the development of sarcopenia and weakness.[19] Therefore, the skeletal muscle mass index (SMI), as reported by Baumgartner et al.,[20] was used as an indicator of muscle dimensions: SMI is calculated by dividing limb muscle mass by the square of subject's height.

LSM was determined using the Japanese version of the Life-Space Assessment (LSA) scale developed by Baker et al.[1] The LSA score was calculated after questioning participants about their range of activities, frequency of engaging in activities, and level of independence over the previous month. The activity range comprised five levels: inside their residence only, at the residence premises, near home (<800 m), within town (<16 km), and outside town (>16 km). Subsequently, the total LSA score was determined according to the presence or absence of outings to each activity area, the frequency of outings, and the method of mobility (independent or with physical or other types of assistance). The LSA score ranges from 0 (indicating that the individual has not been outside of his or her bedroom in the past 4 weeks) to 120 (indicating that the individual has traveled outside of his

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

or her town daily without assistance in the previous 4 weeks).

Concerning the "appropriateness" category, social isolation and fall self-efficacy were studied as LSM-associated factors. The extent of social isolation was obtained using the Japanese version of the Lubben Social Network Scale (LSNS-6),[21] which is a six-item version of the LSNS[22] and is a reliable and validated scale. This classification system comprises items related to emotional and instrumental support, i.e., three items on family networks and three items on nonfamily networks. The total score ranges between 0 and 30 points, and a score of <12 points indicates a socially isolated individual.[21] Fall self-efficacy was assessed using the Fall Efficacy Scale[23] developed by Tinetti et al. (Japanese version[24]). This tool comprises ten items related to the activities of daily living; the level of confidence about performing an activity without falling was evaluated using a 4-point scale. The total score ranges from 10 to 40 points; higher scores indicate a lower fear of falling.

Concerning the "skill" category, cognitive function, lower limb muscle strength, and mobility were investigated as LSM-associated factors. The former was analyzed utilizing the Mini-Mental State Examination (MMSE),[25] which has good reliability and supported validity. The MMSE comprises 11 items—7 items related to verbal tasks and 4 related to movement tasks; the total score ranges between 0 and 30 points.

Lower limb muscle strength was determined using the five-chair stand test (5-CST).[26] The participants were asked to execute five chair stand movements as rapidly as possible. In addition to assessing the lower limb muscle strength, this test is recommended for the initial screening of sarcopenia.[26] Evaluations were performed twice, and the shortest time was used as the representative value. Furthermore, the Timed Up and Go test was used to assess mobility. A multi-timer was used (Multi-timer T.K.K.5801,Takei Kiki Kogyo, Niigata, Japan) to measure the time taken to rise from a chair, walk 3 m, return to the chair, and sit down. The walking speed was set at a comfortable speed based on a previous study.[27] The measurements were conducted in duplicate, and the maximum values were considered important.

Ethical Considerations

Written informed consent was obtained from each participant after they were provided complete information regarding the purpose of this study, the associated risks and benefits, confidentiality, anonymity, and freedom of participation/withdrawal. This study was approved by the Ethics Committee of the International University of Health and Welfare in Okawa, Japan (approval number: 18-Ifh-092).

Statistical Analysis

For data analysis, the participants were divided into two groups: women and men. Endpoint data were evaluated using the Shapiro–Wilk test to test for normal distribution. Between-group comparisons were performed using Mann–Whitney or Student's *t*-test in the case of continuous variables.

Spearman's correlation analysis was used to identify the association between the LSA scores and each categorical factor separately for men and women. Multiple regression analysis was performed with the LSA scores as dependent variables and the scores of the "appropriateness" and "skills" factors as independent variables. Age, BMI, and SMI were included in the multiple regression analysis for adjustment.

Male and female LSM models were previously created to determine the interrelationships between LSM and its associated factors and among these factors. The goodness-of-fit index (GFI), adjusted GFI (AGFI), and the root mean squared error of approximation (RMSEA) were calculated to judge the global fitness of the model. Based on a previous study,[28] GFI >0.95, AGFI >0.90, and RMSEA <0.05 were defined as acceptable GFI criteria. If a model did not fulfill all of these criteria, a modified version was created and tested. For path analysis, standardized direct and indirect effects in addition to the total standardized effect of related factors on LSM were determined. An effect size (ES) of ≤0.1 was considered small, 0.11–0.30 moderate, and 0.31–0.50 high. All statistical analyses were performed using the SPSS Amos 23 statistics package (IBM); the significance level was set at P <0.05. Additionally, the sample size was determined considering the number of independent variables used in the multiple regression analysis.

RESULTS

Comparisons between male and female subjects revealed significantly lower values for SMI and LSA scores in women than in men (**Table 1**), whereas the proportion of socially isolated participants was similar in men (13.1%) and women (13.6%). In women, LSM was significantly correlated with age (r=−0.364, P <0.001), SMI (r=0.251, P=0.010), fall self-efficacy (r=0.306, P <0.001), social isolation (r=0.210, P=0.004), lower limb muscle strength (r=−0.259, P <0.001), mobility (r=−0.370, P <0.001), and cognitive function (r=0.200, P=0.006). In men, however, LSM was significantly associated only with social isolation (r=0.200, P=0.004).

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

Table 1. Gender differences in the data of community-dwelling older people

	Women (n=188)	Men (n=106)	P-value
Age	78.4 ± 5.5	77.5 ± 5.3	0.19
BMI (kg/m^2)	23.0 (20.6–25.6)	22.8 (20.9–24.6)	0.45
SMI (kg/m^2)	5.6 (5.2–6.1)	6.9 (6.4–7.4)	0.00
5-CST (s)	9.3 (7.7–13.4)	9.7 (8.1–11.1)	0.60
MMSE (score)	27.5 (25.0–29.0)	28.0 (26.0–29.0)	0.83
TUG (s)	8.3 (7.4–11.2)	8.4 (7.7–9.4)	0.75
FES (score)	40.0 (36.0–40.0)	40.0 (37.8–40.0)	0.87
LSNS-6 (score)	18.0 (14.0–21.0)	17.0 (13.8–20.0)	0.54
LSA (score)	82.0 (66.0–100.0)	92.0 (82.0–104.0)	0.00

Data are shown as mean ± SD or median (25% percentile − 75% percentile).
Fall Efficacy Scale (FES).

Table 2. Multiple regression analysis of factors associated with the life-space mobility of older women

	Unstandardized coefficients		Standardized coefficients			Collinearity statistics	
Model	B	Standard error	Beta	T	Significance	Tolerance	Variance inflation factor
Constant	115.64	30.18	—	3.83	0.00	—	—
Age	−0.91	0.29	−0.22	−3.17	0.02	0.75	1.33
BMI	−1.81	0.58	−0.27	−3.10	0.02	0.48	2.08
SMI	10.64	3.02	0.32	3.52	0.01	0.45	2.21
Social isolation	0.41	0.25	0.13	1.67	0.09	0.94	1.07
Fall self-efficacy	0.79	0.35	0.15	2.26	0.03	0.86	1.16
Mobility	−1.95	0.92	−0.16	−2.12	0.01	0.64	1.60

Dependent variable: life-space mobility (r=0.57, r^2=0.32).

Table 3. Multiple regression analysis of factors associated with the life-space mobility of older men

	Unstandardized coefficients		Standardized coefficients			Collinearity statistics	
Model	B	Standard error	Beta	T	Significance	Tolerance	Variance Inflation factor
Constant	97.32	17.48		5.57	0.00		
BMI	−2.10	0.82	−0.35	−2.56	0.01	0.45	2.21
SMI	5.86	3.16	0.25	1.85	0.06	0.45	2.21
Social isolation	0.89	0.32	0.27	2.81	0.04	0.93	1.07
Lower limb muscle strength	−1.27	0.60	−0.20	−2.12	0.01	0.99	1.01

Dependent variable: life-space mobility (r=0.50, r^2=0.25).

The results of multiple regression analysis in women, with LSM as the dependent variable, revealed age (β=−0.22), BMI (β=−0.27), SMI (β=0.32), fall self-efficacy (β=0.15), social isolation (β=0.13), and mobility (β=−0.16) as significant factors influencing the LSM (R=0.57, R^2=0.32; **Table 2**); in men, however, BMI (β=−0.35), SMI (β=0.25), social isolation (β=0.27), and lower limb muscle strength (β=−0.20) were identified as significant independent variables (R=0.50, R^2=0.25; **Table 3**). Multicollinearity between the endpoints was considered to be unproblematic; this assumption was

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

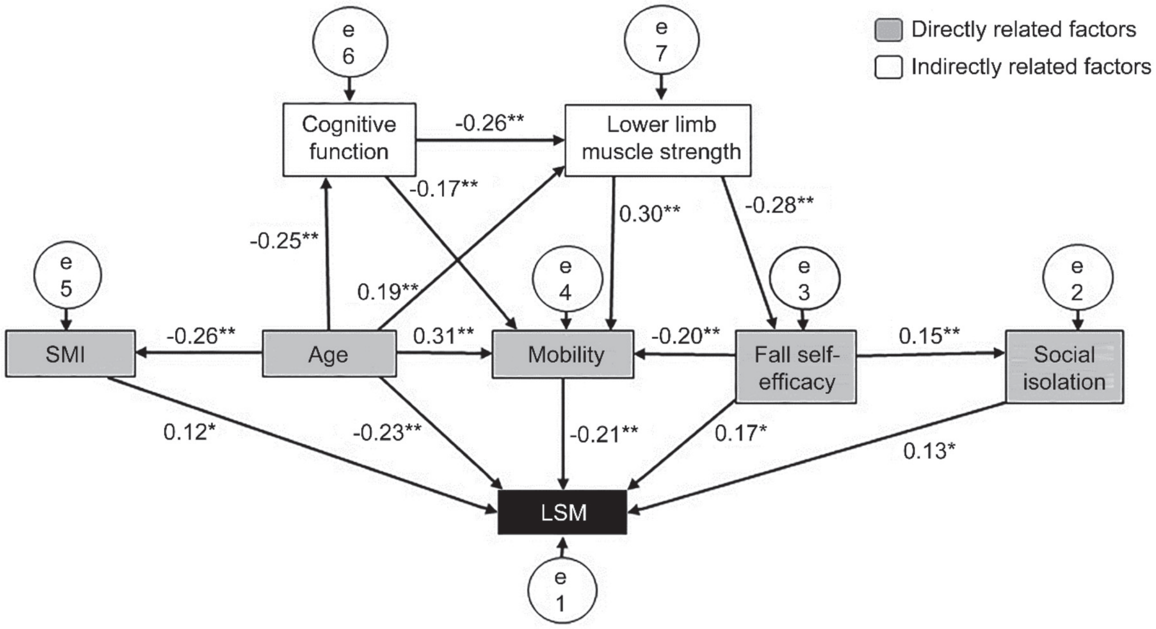

Fig. 1. Interconnectedness of the factors associated with the LSA scores of older women (final model). e, error variable. Path analysis: *P <0.05, **P <0.01, χ^2=19.44 (P=0.11), goodness-of-fit index=0.98, adjusted goodness-of-fit index=0.93, root mean squares error of approximation=0.04. LSM, life-space mobility; SMI, skeletal muscle mass index.

based on the variance inflation factor (VIF) obtained for both women (VIF=1.07–2.21) and men (VIF=1.01–2.21; **Tables 2 and 3**).

Path analysis was performed to establish separate models for men and women by applying the initially determined correlations between the category items and LSM along with the results of multiple regression analysis. The female LSM model was created using participant characteristics such as age and SMI along with items in the “appropriateness” category (fall self-efficacy and social isolation) and in the “skills” category (mobility) as direct factors; the two other characteristics in the “skills” category (lower limb muscle strength and cognitive function) served as indirect factors (**Fig. 1**). The GFI scores of the female LSM model (χ^2=19.44, GFI=0.98, AGFI=0.93, and RMSEA=0.04) indicated an adequate fit. Similarly, the male LSM model was created using participant characteristics such as BMI and SMI along with social isolation and lower limb muscle strength in the “appropriateness” and “skills” categories, respectively, as direct factors; the remaining factors, such as cognitive function, age, mobility, and fall self-efficacy were used as indirect factors (**Fig. 2**). The goodness of fit of the male LSM model (χ^2=37.92, GFI=0.93, AGFI=0.90, and RMSEA=0.04) was also deemed to be adequate. In addition to the different results for men and women, path analysis revealed that SMI and social isolation were common direct factors for LSM, whereas the single common indirect factor was cognitive function. For the male LSM model, the direct factors in descending order of ES were social isolation (ES=0.26), SMI (ES=0.25), lower limb muscle strength (ES=−0.19), and BMI (ES=−0.17). In the female LSM model, the direct factors in descending order of ES were age (ES=−0.37), fall self-efficacy (ES=0.23), mobility (ES=−0.21), social isolation (ES=0.13), and SMI (ES=0.12); age was found to have indirect effects on all the other LSM-associated factors (**Table 4**).

DISCUSSION

In the present study, there were large differences between older men and women in the factors associated with LSM and the relationships among these factors. Path analysis revealed that in the female LSM model, the direct factors in descending order of ES were age, fall self-efficacy, mobility, social isolation, and SMI; moreover, age had an indirect effect on the other factors. In the LSM male and female models, only SMI and social isolation were common direct factors, and cognitive function was the only common indirect factor. To

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

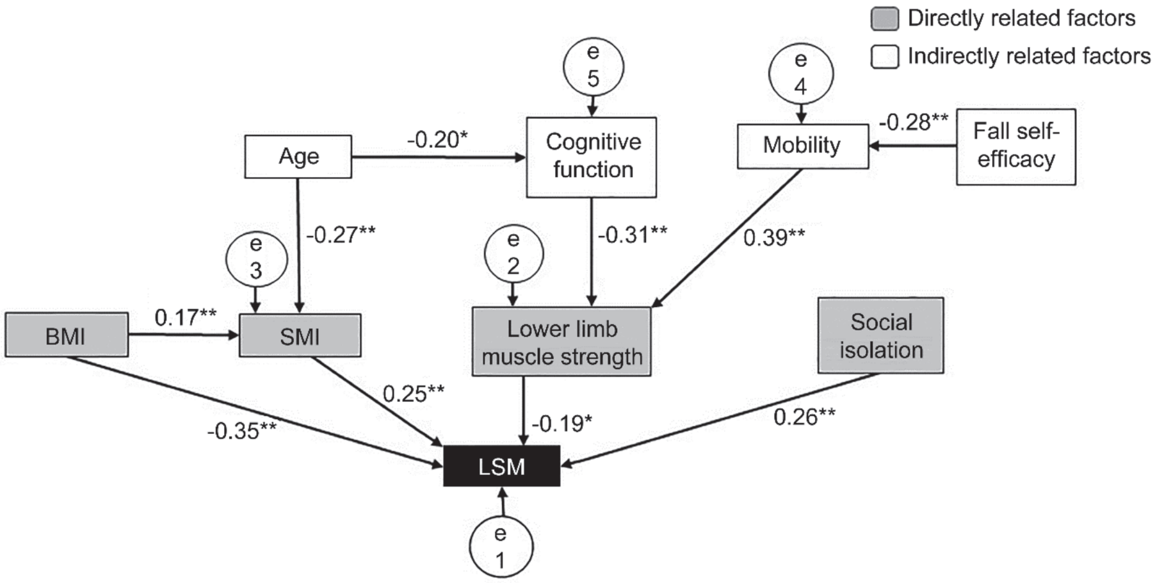

Fig. 2. Interconnectedness of the factors associated with the LSA scores of older men (final model). Path analysis: *P <0.05, **P <0.01, χ^2=37.92 (P=0.06), goodness-of-fit index=0.93, adjusted goodness-of-fit index=0.90, root mean squares error of approximation=0.04.

Table 4. Effects of factors associated with life-space mobility: direct effects, indirect effects, and overall effect

		Variable	Direct effects	Indirect effects	Overall effect size
Women	Properties	Age	−0.23	−0.15	−0.37
		SMI	0.12	—	0.12
	Appropriateness	Social isolation	0.13	—	0.13
		Fall self-efficacy	0.17	0.06	0.23
	Skills	Cognitive function	—	0.09	0.09
		Lower limb muscle strength	—	−0.14	−0.14
		Mobility	−0.21	—	−0.21
Men	Properties	Age	—	−0.08	−0.08
		BMI	−0.35	0.17	−0.17
		SMI	0.25	—	0.25
	Appropriateness	Social isolation	0.26	—	0.26
		Fall self-efficacy	—	0.02	0.02
	Skills	Cognitive function	—	0.06	0.06
		Lower limb muscle strength	−0.19	—	−0.19
		Mobility	—	−0.07	−0.07

The path normalization coefficient ranged from −1.0 to 1.0.
Effect sizes of <0.1, 0.11–0.30, and 0.31– 0.50 indicate low, medium, and substantial effects, respectively.

the best of our knowledge, this study is the first to focus on a structural analysis of the factors affecting LSM in older men and women while considering individual and environmental influences.

LSM-associated Factors and Structures Common to the Male and Female Models

The current study identified SMI as a common factor affecting LSM in both older men and older women. The

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

Asian Working Group for Sarcopenia cutoff SMI values for sarcopenia are <5.7 kg/m^2 for women and <7.0 kg/m^2 for men[29]; in the present cohort, the mean SMIs in men and women were lower than the reference values, suggesting the presence of age-related loss of muscle mass. Sarcopenia is reportedly an independent factor mediating the activities of daily living, increased risk of falls because of frailty, and impaired physical activity[30]; therefore, SMI appears to be a potential common biomarker of LSM in both genders.

A clear association has been reported between mental health and life space in older women, with these individuals being particularly vulnerable to social isolation because of their limited life space and low spatial mobility.[31] Although working after retirement is not expected of women, women who actively engage in household chores appear to continue to bear the burden of such work even after retirement,[6] with studies predicting that the life space of these women will eventually narrow down to their home. In Japan, many older people participate in voluntary local group activities at “community salons”. Local salon activities provide an environment for social connection, thereby motivating older women to stay physically active through small communities. For such participants, the influence of psychological and social network factors on LSM, as indicated in the currently established LSM models, is thus understandable. Older men in urban areas of Japan spend considerably more time out of their homes than women do because of working, participating in groups and associations, socializing with friends, and engaging in hobbies.[32] In rural Japanese regions, establishing a role for older men in organizations and improving opportunities for social participation are crucial because of their benefits in improving physical and mental health.[33] A substantial number of older men in urban areas who participated in our physical fitness study held positions in the respective local community and participated in salon activities. These facts support the finding that social engagement and networking activities are direct factors influencing LSM in the male LSM model.

Cognitive function represents an indirect factor that affects LSM via mobility in men and women similarly (**Figs. 1 and 2**). The components of cognitive function such as processing speed, attention, and executive function decline with age, thereby impairing mobility. Executive function represents the cognitive basis for walking; a lower processing speed leads to a delay between sensory input and response of the motor control system in movement.[34] In addition to attention deficit, a decline in cognitive function poses a risk of balance loss and impaired gait management. Therefore, cognitive function is further verified as a central mediator of mobility limitations.

Factors and Structures Associated with LSM with Differences Between Male and Female Models

In the female model, age was used as an adjustment factor in path analysis with a high overall ES (−0.37) (**Fig. 1** and **Table 4**). Contrary to the situation in men, women have a higher incidence of chronic diseases such as arthritis, depression, osteoporosis, and consecutive fractures[35]; therefore, women experience more physical functional limitations and frailty than men.[36] Women also spend more years than men living with disability, likely during old age. Therefore, older women may be more strongly affected by various factors such as age and have a smaller LSM than older men.

In the female model, fall self-efficacy (ES=0.23) and mobility (ES=−0.21) are direct factors with moderate ESs (**Fig. 1** and **Table 4**). Self-efficacy is a cognitive control system comprising the perceptions of ability and functioning, and it is known to be strongly dependent on individual behavior as well as actual physical ability. The fear of falling is reportedly significantly higher in older women than in older men regardless of whether the women have a history of falling.[37] Furthermore, this fear is associated with poor balance and gait, a poor sense of well-being, depression, and anxiety.[37] Therefor, older women appear to experience an intense decline in cognitive function, lower limb muscle strength, and impairment of other physical functions, with age; all these negative effects translate into psychological anxiety and directly affect the activities of daily living and LSM of older women (**Fig. 1**).

In the male LSM model, lower limb muscle strength (ES=−0.19) and BMI (ES=−0.17) were representative direct factors, whereas fall self-efficacy (ES=0.02) and mobility (ES=−0.07) were indirect factors with small ESs (**Fig. 2** and **Table 4**). Older people with impaired lower extremity function are at an increased risk of developing life-space limitations, particularly if obesity is also present.[38] Furthermore, weight loss has been associated with muscle strength and future walking ability.[39] For men in particular, lower extremity muscle weakness is associated with increased BMI until the age of 65 years; in older men, muscle weakness has been associated with decreased relative leg lean mass.[40] Men are affected earlier than women by age-related changes in BMI, SMI, and lower extremity muscle strength, and in men, age has been considered a direct factor in LSM limitation.

This study has some limitations. First, a relatively small

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

number of community-dwelling older people living in a single prefecture of Japan was included. Therefore, it may not be appropriate to extrapolate the results to older adults belonging to dissimilar cultural or social backgrounds. Second, the numbers of female and male participants in this study were different. Although there was no significant heterogeneity in the age of the participants, this disparity might have been because of the low male participation in the previous elderly physical fitness measurement study. Consequently, future studies must repeat these analyses with an equal number of men and women to verify the reproducibility of the current results. Finally, because of the cross-sectional design of this study, causal relationships between LSM and associated factors could not be determined. Nevertheless, we attempted to comprehensively analyze the factors affecting the LSM of older people and to clarify the mechanisms underlying such effects according to gender differences.

In conclusion, we hypothesized in this study that there are significant differences in the factors and structures associated with LSM in older men and older women. The male and female LSM models and associated factors herein established revealed adequate GFIs, suggesting that gender disparities do exist in the process and overarching structure of mobility restriction. Understanding gender variations in the structure of LSM is crucial for designing interventions aimed at improving the health and functioning of older people. The findings of the present study emphasize the need to consider culture, regional characteristics, and social conjunctures when designing relevant interventions for older people. The causal associations between LSM and its associated factors in older men and women need to be investigated in a future longitudinal study.

ACKNOWLEDGMENTS

This study was supported by the intramural research funds of the International University of Health and Welfare (grant number: not applicable).

CONFLICT OF INTEREST

There are no conflicts of interest to declare.

REFERENCES

1. Baker PS, Bodner EV, Allman RM: Measuring life-space mobility in community-dwelling older adults. J Am Geriatr Soc 2003;51:1610–1614. DOI:10.1046/j.1532-5415.2003.51512.x, PMID:14687391
2. Rantakokko M, Portegijs E, Viljanen A, Iwarsson S, Kauppinen M, Rantanen T: Changes in life-space mobility and quality of life among community-dwelling older people: a 2-year follow-up study. Qual Life Res 2016;25:1189–1197. DOI:10.1007/s11136-015-1137-x, PMID:26407605
3. Kaufmann V, Bergman MM, Joye D: Motility: mobility as capital. Int J Urban Reg Res 2004;28:745–756. DOI:10.1111/j.0309-1317.2004.00549.x
4. Seinsche J, Zijlstra W, Giannouli E: Motility in frail older adults: operationalization of a new framework and first insights into its relationship with physical activity and life-space mobility: an exploratory study. Int J Environ Res Public Health 2020;17:8814. DOI:10.3390/ijerph17238814, PMID:33260952
5. Auais M, Alvarado B, Guerra R, Curcio C, Freeman EE, Ylli A, Guralnik J, Deshpande N: Fear of falling and its association with life-space mobility of older adults: a cross-sectional analysis using data from five international sites. Age Ageing 2017;46:459–465. DOI:10.1093/ageing/afw239, PMID:28043980
6. Silberschmidt S, Kumar A, Raji MM, Markides K, Ottenbacher KJ, Al Snih S: Life-space mobility and cognitive decline among Mexican Americans aged 75 years and older. J Am Geriatr Soc 2017;65:1514–1520. DOI:10.1111/jgs.14829, PMID:28276089
7. Lo AX, Brown CJ, Sawyer P, Kennedy RE, Allman RM: Life-space mobility declines associated with incident falls and fractures. J Am Geriatr Soc 2014;62:919–923. DOI:10.1111/jgs.12787, PMID:24731095
8. Mitsutake S, Koike T, Ishizaki T, Sakurai R, Yasunaga M, Nishi M, Fukaya T, Kobayashi E, Suzuki H, Nonaka K, Saito M, Hasebe M, Murayama Y, Fujiwara Y: Influence of co-existing social isolation and homebound status on medical care utilization and expenditure among older adults in Japan. Arch Gerontol Geriatr 2021;93:104286. DOI:10.1016/j.archger.2020.104286, PMID:33171327

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

9. Fathi R, Bacchetti P, Haan MN, Houston TK, Patel K, Ritchie CS: Life-space assessment predicts hospital readmission in home-limited adults. J Am Geriatr Soc 2017;65:1004–1011. DOI:10.1111/jgs.14739, PMID:28152175
10. Rosso AL, Grubesic TH, Auchincloss AH, Tabb LP, Michael YL: Neighborhood amenities and mobility in older adults. Am J Epidemiol 2013;178:761–769. DOI:10.1093/aje/kwt032, PMID:23666814
11. Curcio CL, Alvarado BE, Gomez F, Guerra R, Guralnik J, Zunzunegui MV: Life-space assessment scale to assess mobility: validation in Latin American older women and men. Aging Clin Exp Res 2013;25:553–560. DOI:10.1007/s40520-013-0121-y, PMID:23949973
12. Isaacson M, Tripathi A, Samanta T, D'Ambrosio L, Coughlin J: Giving voice to the environment as the silent partner in aging: examining the moderating roles of gender and family structure in older adult wellbeing. Int J Environ Res Public Health 2020;17:4373. DOI:10.3390/ijerph17124373, PMID:32570808
13. Choi M, O'Connor ML, Mingo CA, Mezuk B: Gender and racial disparities in life-space constriction among older adults. Gerontologist 2016;56:1153–1160. DOI:10.1093/geront/gnv061, PMID:26185148
14. Taylor JK, Buchan IE, van der Veer SN: Assessing life-space mobility for a more holistic view on wellbeing in geriatric research and clinical practice. Aging Clin Exp Res 2019;31:439–445. DOI:10.1007/s40520-018-0999-5, PMID:30078096
15. Webber SC, Porter MM, Menec VH: Mobility in older adults: a comprehensive framework. Gerontologist 2010;50:443–450. DOI:10.1093/geront/gnq013, PMID:20145017
16. Matsuda K, Hamachi N, Yamaguchi T, Oka S, Suzuki A, Shimoda T, Ikeda T, Eguchi M, Nakahara M, Nagai Y, Takano Y, Kaneko H, Morita M: A path analysis of the interdependent relationships between life space assessment scores and relevant factors in an elderly Japanese community. J Phys Ther Sci 2019;31:326–331. DOI:10.1589/jpts.31.326, PMID:31037003
17. Hamachi N, Yamaguchi T, Kaneko H, Takano Y, Nakahara M, Nagai Y, Eguchi M, Matsuda K, Ikeda T, Oka S, Shimoda T, Suzuki A, Morita M: Relationships between life spaces and motor functions among the community-dwelling elderly [in Japanese]. Rigakuryoho Kagaku 2019;34:485–489. DOI:10.1589/rika.34.485
18. Yoshida D, Shimada H, Park H, Anan Y, Ito T, Harada A, Suzuki T: Development of an equation for estimating appendicular skeletal muscle mass in Japanese older adults using bioelectrical impedance analysis. Geriatr Gerontol Int 2014;14:851–857. DOI:10.1111/ggi.12177, PMID:24450604
19. Robertson DA, Savva GM, Kenny RA: Frailty and cognitive impairment—a review of the evidence and causal mechanisms. Ageing Res Rev 2013;12:840–851. DOI:10.1016/j.arr.2013.06.004, PMID:23831959
20. Baumgartner RN, Koehler KM, Gallagher D, Romero L, Heymsfield SB, Ross RR, Garry PJ, Lindeman RD: Epidemiology of sarcopenia among the elderly in New Mexico. Am J Epidemiol 1998;147:755–763. DOI:10.1093/oxfordjournals.aje.a009520, PMID:9554417
21. Kurimoto A, Awata S, Ohkubo T, Tsubota-Utsugi M, Asayama K, Takahashi K, Suenaga K, Satoh H, Imai Y: Reliability and validity of the Japanese version of the abbreviated Lubben Social Network Scale [In Japanese]. Nippon Ronen Igakkai Zasshi 2011;48:149–157. DOI:10.3143/geriatrics.48.149, PMID:21778631
22. Lubben JE, Gironda ME: Centrality of social ties to the health and well-being of older adults. In: Social work and health care in an aging world (eds, Berkman L, Harooytan L). New York, Springer Press, 2003;319–350.
23. Tinetti ME, Richman D, Powell L: Falls efficacy as a measure of fear of falling. J Gerontol 1990;45:P239–P243. DOI:10.1093/geronj/45.6.P239, PMID:2229948
24. Haga H: Scaling of consideration and attitude to falling among the elderly in Hokkaido. Comprehensive study on falls and fractures in the community elderly in Japan, Scientific research grants (science research grant-in-aid) study for submission of results report (Education Science Ministry issued minutes) of 1995–1996 fiscal year (Research representative: Shibata H) 1997;127–136.
25. Folstein M: Mini-mental and son. Int J Geriatr Psychiatry 1998;13:290–294. PMID:9658261
26. Dodds RM, Murray JC, Granic A, Hurst C, Uwimpuhwe G, Richardson S, Brayne C, Matthews FE, Sayer AA, MRC CFAS: Prevalence and factors associated with poor performance in the 5-chair stand test: findings from the Cognitive Function and Ageing Study II and proposed Newcastle protocol for use in the assessment of sarcopenia. J Cachexia Sarcopenia Muscle 2021;12:308–318. DOI:10.1002/jcsm.12660, PMID:33463015

Copyright © 2022 The Japanese Association of Rehabilitation Medicine

27. Podsiadlo D, Richardson S: The timed "Up & Go": a test of basic functional mobility for frail elderly persons. J Am Geriatr Soc 1991;39:142–148. DOI:10.1111/j.1532-5415.1991.tb01616.x, PMID:1991946
28. Browne MW, Cudeck R: Alternative ways of assessing model fit. Sociol Methods Res 1992;21:230–258. DOI:10.1177/0049124192021002005
29. Chen LK, Woo J, Assantachai P, Auyeung TW, Chou MY, Iijima K, Jang HC, Kang L, Kim M, Kim S, Kojima T, Kuzuya M, Lee JS, Lee SY, Lee WJ, Lee Y, Liang CK, Lim JY, Lim WS, Peng LN, Sugimoto K, Tanaka T, Won CW, Yamada M, Zhang T, Akishita M, Arai H: Asian Working Group for Sarcopenia: 2019 consensus update on sarcopenia diagnosis and treatment. J Am Med Dir Assoc 2020;21:300–307.e2. DOI:10.1016/j.jamda.2019.12.012, PMID:32033882
30. Wilkinson DJ, Piasecki M, Atherton PJ: The age-related loss of skeletal muscle mass and function: measurement and physiology of muscle fibre atrophy and muscle fibre loss in humans. Ageing Res Rev 2018;47:123–132. DOI:10.1016/j.arr.2018.07.005, PMID:30048806
31. Byles JE, Leigh L, Vo K, Forder P, Curryer C: Life space and mental health: a study of older community-dwelling persons in Australia. Aging Ment Health 2015;19:98–106. DOI:10.1080/13607863.2014.917607, PMID:24903196
32. Saito T, Kondo K, Murata C, Jeong S, Suzuki K, Kondo N, JAGES Group: [Gender and regional differences in going out, social, and leisure activities among older adults. Findings from the JAGES Project] [In Japanese]. Nihon Koshu Eisei Zasshi 2015;62:596–608. DOI:10.11236/jph.62.10_596, PMID:26607919
33. Takagi D, Kondo K, Kawachi I: Social participation and mental health: moderating effects of gender, social role and rurality. BMC Public Health 2013;13:701. DOI:10.1186/1471-2458-13-701, PMID:23902596
34. Harada CN, Natelson Love MC, Triebel KL: Normal cognitive aging. Clin Geriatr Med 2013;29:737–752. DOI:10.1016/j.cger.2013.07.002, PMID:24094294
35. United Nations Department of Economic and Social Affairs: The World's Women 2015: Trends and Statistics 2015;15:8.
36. Rotarou ES, Sakellariou D: Structural disadvantage and (un)successful ageing: gender differences in activities of daily living for older people in Chile. Crit Public Health 2019;29:534–546. DOI:10.1080/09581596.2018.1492092
37. Liu JY: Fear of falling in robust community-dwelling older people: results of a cross-sectional study. J Clin Nurs 2015;24:393–405. DOI:10.1111/jocn.12613, PMID:24787119
38. Tsuji T, Rantakokko M, Portegijs E, Viljanen A, Rantanen T: The effect of body mass index, lower extremity performance, and use of a private car on incident life-space restriction: a two-year follow-up study. BMC Geriatr 2018;18:271. DOI:10.1186/s12877-018-0956-3, PMID:30409120
39. Snih SA, Raji MA, Markides KS, Ottenbacher KJ, Goodwin JS: Weight change and lower body disability in older Mexican Americans. J Am Geriatr Soc 2005;53:1730–1737. DOI:10.1111/j.1532-5415.2005.53522.x, PMID:16181172
40. Alcazar J, Aagaard P, Haddock B, Kamper RS, Hansen SK, Prescott E, Alegre LM, Frandsen U, Suetta C: Age- and sex-specific changes in lower-limb muscle power throughout the lifespan. J Gerontol A Biol Sci Med Sci 2020;75:1369–1378. DOI:10.1093/gerona/glaa013, PMID:31943003

Copyright © 2022 The Japanese Association of Rehabilitation Medicine