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Original Article

Predictors of life-space mobility in patients with fracture 3 months after discharge from convalescent rehabilitation ward: a prospective longitudinal study

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Abstract. [Purpose] To identify predictors of life-space mobility in patients with fracture three months after discharge from convalescent rehabilitation ward. [Participants and Methods] This is a prospective longitudinal study that included patients aged 65 or older with a fracture who were scheduled for discharge home from the convalescent rehabilitation ward. Baseline measurements included sociodemographic variables (age, gender, and disease), the Falls Efficacy Scale-International, maximum walking speed, the Timed Up & Go test, the Berg Balance Scale, the modified Elderly Mobility Scale, the Functional Independence Measure, the revised version of Hasegawa's Dementia Scale, and the Vitality Index up to two weeks before discharge. As a follow-up, the life-space assessment was measured three months after discharge. In the statistical analysis, multiple linear and logistic regression analyses were performed with the life-space assessment score and the life-space level of "places outside your town" as dependent variables. [Results] The Falls Efficacy Scale-International, the modified Elderly Mobility Scale, age, and gender were selected as predictors in the multiple linear regression analysis, whereas in the multiple logistic regression analysis, the Falls Efficacy Scale-International, age, and gender were selected as predictors. [Conclusion] Our study emphasized the importance of fall-related self-efficacy and motor function for life-space mobility. The findings of this study suggest that when considering post-discharge living, therapists should conduct an appropriate assessment and adequate planning.

Key words: Life-space mobility, Predictor, Convalescent rehabilitation ward

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INTRODUCTION

Life-space mobility is an important factor in the quality of life (QOL) of elderly individuals[1]. Life-space mobility is a concept for assessing the extent of an individual's movement including the frequency of movement and the degree of independence during movement[2, 3]. The relationship between the functional status measured by activities of daily living (ADL) and health-related QOL (HRQOL) is mediated by life-space mobility[4]. Namely, functional status limitations predict lower levels of life-space mobility, thereby predicting diminished HRQOL. Life-space mobility is known a predictor over time of health outcomes such as instrumental ADL (IADL)[5], QOL[1, 6], cognitive decline[7–9], healthcare utilization (emergency department visits, hospitalizations, and hospital readmissions)[10, 11], admission to nursing homes[12], incidence of frailty[13], incidence of falls[14], and mortality[11, 13, 15–17].

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Several studies have examined the relationships between sociodemographic variables, physical factors, psychological factors and life-space mobility[3, 18–23]. Peel et al.[3] reported that ADL, IADL and physical performance accounted for 45.5% of the variance in Life-Space Assessment (LSA) score in regression analysis. They also reported that sociodemographic variables such as age, gender and others accounted for 12.7% of the variance. Auais et al.[18] identified a significant relationship between fall-related self-efficacy and life-space mobility, even after adjusting for functional, clinical and sociodemographic confounders. Tashiro et al.[19] reported that limitations in ADL, walking speed, and fall-related self-efficacy were independently related to LSA score among community-living individuals with stroke. In addition, several studies have examined longitudinal relationships with life-space mobility. Nakao et al.[24] determined predictors of life-space mobility among patients with stroke at two months after discharge from a post-acute rehabilitation ward using multiple regression analysis. They reported that gender, age, cognitive score, Timed Up & Go test (TUG), length of hospital stay, and fall-related self-efficacy as predictors.

Most studies on life-space mobility have been conducted on community-dwelling elderly people, and few studies have investigated hospitalized patients. A significant reduction in life-space mobility was common after hospitalization[25]. Among patients with a reduction in life-space mobility, 34% did not recover to pre-hospitalization levels of life-space mobility. Life-space mobility in elderly individuals declines in association with falls, with or without injury, in the subsequent six months[26]. In particular, the combination of a fall and any fracture results in a greater decline in life-space mobility. Preventing reductions in life-space mobility is therefore important for patients with fracture after discharge from hospital.

To optimize the prevention of declines in life-space mobility after discharge, predictors related to life-space mobility need to be identified. Predicting the prognosis of life-space mobility in a patient may help set appropriate rehabilitation goals while the patient is in convalescent rehabilitation wards. The purpose of this study was to identify predictors of life-space mobility at three months after discharge among elderly patients with lower limb, pelvis, or spine fracture admitted to a convalescent rehabilitation ward.

PARTICIPANTS AND METHODS

This was a longitudinal, prospective and observational study conducted at a single institution. The study period was from April 1, 2020 to January 30, 2022. Inclusion criteria for patients were: age ≥65 years; fracture of the lower limb, pelvis, or spine; and discharge home from a convalescent rehabilitation ward. Exclusion criteria were: higher brain dysfunction that prevented measurement of study items; revised version of Hasegawa's Dementia Scale (HDS-R) score <20; non-ambulatory status after discharge; stay in the convalescent rehabilitation ward <two weeks; or any missing results.

Measurements were taken twice: baseline measurements, up to two weeks before discharge from the convalescent rehabilitation ward; and follow-up measurement, three months after discharge.

Baseline measurements as potential predictors included sociodemographic variables (age, gender, disease), Falls Efficacy Scale-International (FES-I), maximum walking speed (MWS), TUG, Berg Balance Scale (BBS), modified Elderly Mobility Scale (mEMS), Functional Independence Measure (FIM), HDS-R and Vitality Index (VI). Potential predictors were selected according to previous studies[3, 18–24] or clinical experience.

The FES-I is a scale of fall-related self-efficacy that examines whether the individual can perform 16 tasks without falling[27]. Participants were asked to answer each of the 16 items on a score of 1 ("not at all concerned") to 4 ("very concerned"), resulting in a total score of 16–64. The validity, reproducibility, reliability and responsiveness of the FES-I has been confirmed[28]. A lower score indicates better fall-related self-efficacy.

In measuring MWS, a 10-m walk test was performed. Participants were given 3-m to accelerate and decelerate before and after the test distance[29]. Participants were asked to walk the 16-m distance at maximum speed, and the walking time for the central 10-m was measured.

The TUG[30] measured the time taken to stand up from a chair, walk around a mark 3-m away, return to the chair and sit down again.

The BBS[31, 32] is a balance test comprising 14 daily activities. Each of the 14 items was scored from 0 to 4 points, for a total score of 0–56. Higher score indicates greater balance ability.

The mEMS[33] was developed as a simple scale to evaluate motor function for the elderly. The scale includes eight items, each of which is scored from 0 to 4 points, with a total score of 0–23. Higher score indicates better motor function.

The FIM[34–36] is a scale evaluating basic ADL (BADL). The measure includes 18 BADLs, scored from 1 ("total assistance") to 7 ("complete independence"). A total score of 18–126 is calculated. Higher score indicates more independence in ADL.

The HDS-R[37] is a scale of nine items for screening cognitive function. A total score of 0–30 is calculated. Higher score indicates better cognitive function.

The VI[38] is an index of five items to evaluate motivation in the elderly, yielding a total score of 0–10. Higher score indicates higher motivation.

Follow-up comprised the LSA interview by telephone contact at three months after discharge from the convalescent rehabilitation ward. The LSA[39] is a scale that evaluates life-space mobility based on the range of mobility, frequency, and level of independence during the past month. The life-space level is evaluated on five levels: level 1="other rooms of your home besides the room where you sleep", level 2="an area outside your home such as your porch, deck, or patio; hallway of an apartment building; or garage", level 3="places in your neighborhood", level 4="places outside your neighborhood but within your town", and level 5="places outside your town". The validity of the Japanese version of the LSA has been shown[40]. Scores ranged from 0 to 120, and the method of calculating the total score was based on previous research[3, 40]. Higher score indicates a wider range of mobility and greater independence in activities.

For statistical analyses, the unpaired t-test and χ^2 test were performed to compare participants with completed follow-up measurements (follow-up group) and participants without completed follow-up measurements (no follow-up group). The unpaired t-test and χ^2 test were performed to compare differences in LSA score by gender. To estimate the association between baseline measurements and LSA score, Pearson product-moment correlation coefficients were calculated for each item in the follow-up group. To identify predictors affecting life-space mobility at three months after discharge from the convalescent rehabilitation ward, multiple linear regression analysis and multiple logistic regression analysis were performed. LSA score was the dependent variable in multiple linear regression analysis. Furthermore, the life-space level of "places outside your town" was the dependent variable in multiple logistic regression analysis. Measurements showing an absolute value for the correlation coefficient of >0.4 with LSA score were defined as independent variables. Selection of these independent variables was based on the forward-backward stepwise selection method in multiple linear regression analysis and the likelihood ratio forward selection method in multiple logistic regression analysis.

All statistical analyses were analyzed using SPSS for Windows version 25.0 (IBM Corp., Armonk, NY, USA), with values of $p<0.05$ considered significant.

This study received ethical approval from the institutional review board at the Geriatrics Research Institute and Hospital (approval no. 81). The purpose of this study was explained to all participants both orally and in writing, and consent was obtained in writing before the study was conducted.

RESULTS

A flow diagram of participation is shown in Fig. 1. Ultimately, 93 patients with fracture agreed to participate in this study. Participant characteristics and results from FES-I, MWS, TUG, BBS, mEMS, FIM, HDS-R, and VI for all participants and for the follow-up and no follow-up groups at the time of discharge from the convalescent rehabilitation ward are shown in Table 1. No significant differences were identified between follow-up and no follow-up groups.

Detailed results for LSA sub-items are shown in Table 2. Mean (standard deviation) LSA score for all participants was 50.2 (21.9). LSA score was significantly higher for males than for females ($p<0.05$). The number of individuals for whom life-space level was "places outside your town" was significantly higher for males than for females. No significant differences were identified for any other sub-items of the LSA.

The results of correlation analysis are shown in Table 3. LSA showed significant moderate correlations with FES-I, MWS, TUG, BBS, and mEMS, and significant weak correlations with FIM and HDS-R.

In multiple linear regression analysis and multiple logistic regression analysis, age, FES-I, MWS, BBS, and mEMS were selected as independent variables based on correlation coefficients >0.4. TUG showed a correlation coefficient >0.4, but also displayed a high correlation with MWS ($r>0.8$). Considering multicollinearity, MWS showed a higher correlation coefficient with LSA and was therefore selected. Gender was also selected as an independent variable because of the significant differences in LSA score between males and females. The results of multiple linear regression analysis are shown in Table 4. FES-I, mEMS, age and gender were selected as significant variables. The adjusted R^2 was 0.41. The results of multiple logistic regression analysis are shown in Table 5. FES-I, age and gender were selected as significant variables.

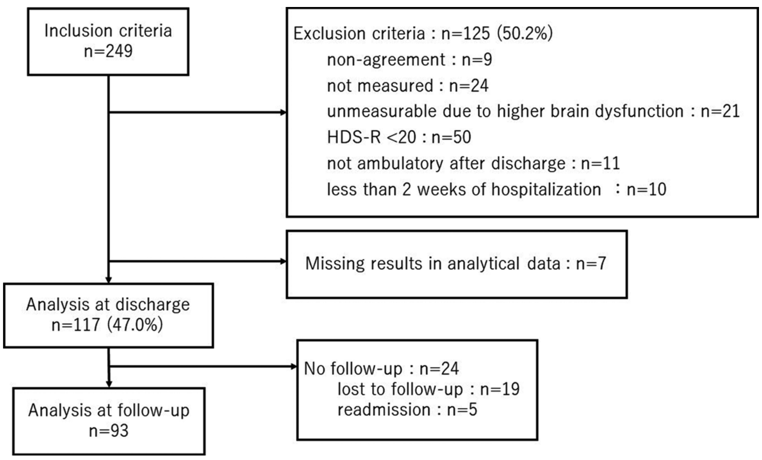

Fig. 1. Flow diagram of participation in the present study.

Table 1. Characteristics of participants at discharge

	All (n=117)	Follow-up (n=93)	No follow-up (n=24)
Age (years)	79.9 (7.6)	80.0 (7.8)	79.3 (6.6)
Gender (female/male)	97/20	76/17	21/3
Hospitalization period in convalescent rehabilitation ward (days)	50.9 (21.0)	49.1 (20.5)	57.7 (21.8)
Spinal fracture	53	40	13
Pelvic fracture	16	15	1
Hip fracture	40	30	10
Knee fracture	4	4	0
Ankle fracture	4	4	0
FES-I (scores)	41.7 (11.9)	41.5 (12.3)	42.7 (10.6)
MWS (m/s)	1.00 (0.31)	0.98 (0.30)	1.06 (0.34)
TUG (s)	14.2 (5.6)	14.3 (5.4)	13.6 (6.1)
BBS (scores)	47.8 (8.2)	47.8 (8.2)	47.7 (8.4)
mEMS (scores)	19.4 (2.8)	19.5 (2.7)	18.6 (3.2)
FIM (scores)	111.2 (10.7)	111.6 (10.5)	109.5 (11.6)
HDS-R (scores)	27.8 (2.4)	27.9 (2.3)	27.4 (2.8)
VI (scores)	9.7 (0.6)	9.7 (0.6)	9.7 (0.7)

FES-I: Falls Efficacy Scale-International; MWS: Maximum Walking Speed; TUG: Timed Up&Go test; BBS: Berg Balance Scale; mEMS: modified Elderly Mobility Scale; FIM: Functional Independence Measure; HDS-R: revised version of Hasegawa's Dementia Scale; VI: Vitality Index.
Values are shown as mean (standard deviation).
No significant differences were identified between follow-up and no follow-up groups.

DISCUSSION

To the best of our knowledge, as far as we know, this represents the first report of a prospective cohort study of patients with fracture who discharged home from a convalescent rehabilitation ward. FES-I, mEMS, age, and gender were identified as predictors of LSA score. With FES-I, age, and gender revealed as predictors of the life-space level of "places outside your town".

Generally, elderly individuals tend to have smaller life-space mobility than younger people. A study of LSA in a normative population showed that LSA scores were lower among individuals ≥70 years of age than among those aged 50–69 years [41]. In addition, a Japanese retrospective cross-sectional study of patients with stroke identified older age as a factor in lower LSA score[24]. The present study showed that LSA scores were lower in older patients with fracture as well as in older patients.

Previous studies in a normative population[41] and in patients with stroke[24] showed that females have lower LSA scores than males. The present study likewise showed that females have lower LSA scores than males among older patients with fracture. In Japan, the percentage of drivers' license holders is higher in males than in females[42]. In particular, the percentage of drivers' license holders among individuals ≥65 years of age is 60% for males and 40% for females. Viljanen et al.[43] reported that car drivers without walking difficulties had the highest life-space mobility scores, whereas car passengers with walking difficulties had the lowest scores. The percentage of drivers' license holders may be related to these gender differences in LSA scores[22].

The most interesting finding of the present study was that fall-related self-efficacy was associated with LSA score and the life-space level of "places outside your town" at three months after discharge, independent of walking and balance functions. A cross-sectional study showed an association between LSA and FES-I[18], but the present longitudinal study found that FES-I at discharge was associated with LSA score at three months after discharge. However, although a Japanese retrospective cross-sectional study of patients with stroke selected TUG as a predictor[24], the present study did not select walking and balance measures. This is likely because participants in this study were limited to patients whose mode of transportation was walking. A systematic review[44] of inpatients and outpatients reported that MWS in patients ≥70 years old was 0.89 m/s (95% confidence interval, 0.75–1.02). Mean age for the follow-up group in this study was 80.0 (7.8) years, mean MWS was 0.98 (0.30) m/s, and the mode of transportation after discharge was walking. Walking and balance measures may not have been selected as predictors of LSA because participants in this study had higher walking function than general inpatients and outpatients. Further investigation is needed to clarify predictors associated with future LSA by grouping participants according to walking function.

The mEMS was selected as a predictor of LSA score. This scale evaluates the motor function of the elderly. The eight sub-items of the mEMS are: lying to sitting; sitting to lying; sit to stand; stand; gait; timed 10-m walk; functional reach; and stairs[33]. Compared to the BBS and MWS, mEMS may have been selected as a predictor because sub-items of the mEMS include difficult items such as going up/down stairs.

Table 2. Detailed results of the Life-Space Assessment

	All	Female	Male	p-value
Mean (SD)	50.2 (21.9)	47.9 (20.3)	60.6 (26.3)	*
95% Confidence Interval (lower–upper)	45.7–54.7	43.3–52.5	47.1–74.1	
Min–Max	12–100	19–100	12–100	
Level 1				
life-space level (yes/no)	93/0	76/0	17/0	Unable to calculate
frequency per week (less than 1/1–3 times/4–6 times/daily)	0/0/1/92	0/0/1/75	0/0/0/17	
independence	0/31/62	0/27/49	0/4/13	
(personal assistance/equipment only/no equipment or personal assistance)				
Level 2				
life-space level (yes/no)	93/0	76/0	17/0	Unable to calculate
frequency per week (less than 1/1–3 times/4–6 times/daily)	3/12/12/66	2/11/11/52	1/1/1/14	
independence	10/32/51	9/28/39	1/4/12	
(personal assistance/equipment only/no equipment or personal assistance)				
Level 3				
life-space level (yes/no)	92/1	76/0	16/1	
frequency per week (less than 1/1–3 times/4–6 times/daily)	6/36/16/34	5/32/11/28	1/4/5/6	
independence	24/30/38	21/25/30	3/5/8	
(personal assistance/equipment only/no equipment or personal assistance)				
Level 4				
life-space level (yes/no)	88/5	72/4	16/1	
frequency per week (less than 1/1–3 times/4–6 times/daily)	15/47/17/9	14/38/13/7	1/9/4/2	
independence	51/14/23	46/10/16	5/4/7	
(personal assistance/equipment only/no equipment or personal assistance)				
Level 5				
life-space level (yes/no)	43/50	30/46	13/4	**
frequency per week (less than 1/1–3 times/4–6 times/daily)	29/9/5/0	23/5/2/0	6/4/3/0	
independence	27/2/14	20/2/8	7/0/6	
(personal assistance/equipment only/no equipment or personal assistance)				

*p<0.05, **p<0.01. If the life-space level is "no", then the participant is not included in "frequency per week" or "independence".

Table 3. Results of correlation analysis for follow-up participants

	Age	FES-I	MWS	TUG	BBS	mEMS	FIM	HDS-R	VI
LSA	−0.48**	−0.40**	0.48**	−0.44**	0.42**	0.43**	0.38**	0.26*	0.06

*p<0.05, **p<0.01.
FES-I: Falls Efficacy Scale-International; MWS: Maximum Walking Speed; TUG: Timed Up&Go test; BBS: Berg Balance Scale; mEMS: modified Elderly Mobility Scale; FIM: Functional Independence Measure; HDS-R: revised version of Hasegawa's Dementia Scale; VI: Vitality Index; LSA: Life-Space Assessment.

Table 4. Results of multiple regression analysis using stepwise selection

	Beta	p-value	VIF
FES-I	−0.29	**	1.05
mEMS	0.28	**	1.12
Age	−0.34	**	1.13
Gender	0.19	*	1.01

*p<0.05, **p<0.01.
FES-I: Falls Efficacy Scale-International; mEMS: modified Elderly Mobility Scale; VIF: variance inflation factor.

Table 5. Results of multivariable logistic regression analysis

	Odds ratio	95% CI		p-value
		lower	upper	
FES-I	0.92	0.882	0.966	**
Age	0.93	0.875	0.998	*
Gender	6.54	1.589	26.94	**

*p<0.05, **p<0.01.
FES-I: Falls Efficacy Scale-International; CI: confidence interval.

Several limitations to this study must be considered. First, the follow-up period was during the coronavirus disease 2019 (COVID-19) pandemic. This may have affected the frequency and range of outings of participants. A study examining the impact of the COVID-19 pandemic on LSA[45] reported that LSA scores from level 2 to level 5 were significantly reduced. A study in Japan[46] reported that 20% of participants did not reach level 5 during the state of emergency declaration, although no significant difference in LSA score was identified. Yamada et al.[47] reported significantly decreased physical activity (PA) among community-dwelling elderly people before and during the COVID-19 epidemic. They also reported that elderly people who lived alone and were socially inactive showed a greater decrease in PA.

Second, sociodemographic variables other than age and gender were not sufficiently examined. We did not include family composition, financial situation, or utilization status of long-term care insurance services in this analysis. These variables are potentially important confounding factors. An analysis including sociodemographic variables should thus be undertaken with a larger sample size. Further studies taking these limitations into account need to be performed.

This study found that gender, age, mEMS, and FES-I predicted LSA at three months after discharge in patients with lower limb, pelvis, or spine fracture. Our study emphasized the importance of fall-related self-efficacy as well as motor function in the elderly for life-space mobility. The findings of this study give hints to the kinds of rehabilitation assessment and planning that therapists should perform when considering post-discharge living. We believe that these findings will help in setting appropriate rehabilitation goals and planning rehabilitation programs in convalescent rehabilitation wards.

Conflict of interest

The authors have no conflicts of interest to disclose.

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