

Factors Associated with Physical Activity in Community-dwelling Older Adults Undergoing Rehabilitation : A Prospective Observational Study

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Background : Maintaining and increasing daily physical activity is important for the health of older adults, including community-dwelling older adults requiring long-term care. However, physical activity levels in this population have not been sufficiently investigated.

Objective : To measure quantitatively the amount of physical activity, which was categorized as locomotive and daily-living activities, in community-dwelling older adults with in-home and daycare rehabilitation, and clarify the associated factors.

Methods : This prospective cross-sectional study included 54 community-dwelling older adults requiring long-term care who received in-home and daycare rehabilitation. Physical activity, including locomotive and daily-living activities, was measured using a triaxial accelerometer. Associated factors assessed included physical, cognitive, and mental function ; sleep quality ; and activity of daily living (ADL) performance. Univariate and multivariate regression analyses were performed to determine factors associated with locomotive and daily-living activities.

Results : The amount of physical activity was low, with locomotive activity considerably low. Physical function and ADL performance were associated with locomotive and daily-living activities. Depression was associated with reduced locomotive activity, whereas sleep quality was associated with daily-living activity.

Conclusions : Community rehabilitation is necessary to improve physical function, ADL independence, depression, and sleep quality to increase physical activity levels, particularly locomotion and daily-living activity levels in community-dwelling older adults requiring long-term care. *Shinshu Med J 73 : 89—97, 2025*

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Key words : physical activity, activity of daily living, depression, sleep quality, community-dwelling older adults

I Introduction

Lack of physical activity in older adults increases the risk of developing various diseases, dysfunctions, disabilities, and loss of independence¹⁾. The “2023 Physical Activity Guidelines for Health Promotion”²⁾ by the

Ministry of Health, Labour and Welfare stated that maintaining adequate physical activity can prevent conditions requiring long-term care for activities of daily living (ADLs). Maintaining and increasing daily physical activity is important for healthy older adults²⁾ and community-dwelling older adults requiring long-term care.

Quantitatively measuring and characterizing daily physical activity is essential for developing strategies to prevent frailty and other conditions that lead to long-term care in older adults³⁾. Objective evalua-

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tions using activity meters equipped with triaxial accelerometers are more accurate than subjective methods, such as questionnaires, for assessing physical activity levels⁴⁾. Physical activity is defined as “any movement produced by the contraction of skeletal muscles that increases energy expenditure above resting levels” and is categorized into “locomotive activities” (e.g., walking, jogging) and “daily-living activities” (e.g., toileting, dressing)⁵⁾⁶⁾.

Several previous studies⁷⁾⁻⁹⁾ have provided normative data on physical activity characteristics in community-dwelling healthy older adults using activity meters. For this group, physical activity is related to physical health⁹⁾¹⁰⁾, cognition¹¹⁾, depression¹²⁾, sleep quality¹³⁾, and ADL independence¹⁴⁾. Although physical activity in older adults undergoing community rehabilitation has been studied¹⁵⁾⁻¹⁷⁾, the factors influencing their activity levels remain unclear.

Individualized interventions such as in-home visits and daycare programs are essential in community rehabilitation settings¹⁸⁾. Therefore, accurately assessing physical activity levels by separating “locomotive activities” and “daily-living activities” is necessary to analyze them in detail. Identifying factors associated with these activities may help in tailoring rehabilitation interventions for community-dwelling older adults.

This study aimed to examine the amount of physical activity, categorized into locomotive and daily-living activities, and investigate the factors influencing these activities, including participant characteristics; physical, cognitive, and mental functions; and ADL performance.

II Materials and Methods

A Design and setting

This prospective observational study was conducted at a rehabilitation clinic providing in-home and daycare rehabilitation to community-dwelling older adults eligible for long-term care insurance. Rehabilitation programs were tailored to the participants' conditions and administered by occupational and physiotherapists. During the in-home rehabilitation intervention, the participants underwent a single 40-min occupa-

tional therapy or physiotherapy session, on average, twice a week to maintain physical and cognitive functions and support their ADL independence. During the daycare rehabilitation intervention, the participants visited the clinic and underwent a single 30-min individual rehabilitation session, on average, twice a week. Sessions focused on functional maintenance and ADL independence. In addition to individual rehabilitation, group rehabilitation sessions focusing on exercise were also provided.

B Participants

The study participants were community-dwelling older adults aged ≥ 65 years who received in-home or daycare rehabilitation at a rehabilitation clinic between April 2020 and March 2022. Individuals diagnosed with dementia or aphasia or who were completely bedridden were excluded from the study.

C Clinical characteristics

The following basic attributes of the participants were collected from their medical records: age, sex, care level (1-5), service type (in-home/daycare), pain intensity, sleep disorders, and locomotion type (walking/wheelchair use). Pain intensity was measured on a 10-point scale (1 = lowest pain, 10 = worst imaginable pain). Sleep disorders were subjectively evaluated using the Athens Insomnia Scale (AIS)¹⁹⁾, in which scores ≥ 4 indicated suspected insomnia. Occupational and physiotherapists assessed physical, cognitive, and mental functions, as well as ADL performance. Physical function was evaluated using the Short Physical Performance Battery (SPPB)²⁰⁾, which evaluates standing balance, gait, and lower extremity muscle strength. This test uses a 14-point scale, with higher scores indicating better function. Cognitive function was assessed using the Japanese version of the Mini-Mental State Examination (MMSE-J)²¹⁾, with a score of ≤ 23 on a 30-point scale indicating cognitive impairment. Depressive symptoms were assessed using the Geriatric Depression Scale (GDS)²²⁾, with scores ≥ 5 on a 15-point scale indicating depressive tendencies and ≥ 10 indicating depression. ADL performance was evaluated using the Functional Independence Measure (FIM)²³⁾, which is a 126-point scale, with higher scores indicating greater independence. FIM

locomotion indicates 7 points for independence and 1 point for requiring heavy assistance.

D Measurement of activity

The amount of physical activity was measured using the Active Style Pro HJA-750C (OMRON HEALTHCARE Co. Ltd., Kyoto, Japan), an activity meter equipped with a triaxial accelerometer. The measurements were obtained by recording acceleration data over a 10-s epoch. The obtained data were processed using a high-pass filter with a cutoff frequency of 0.7 Hz, and the ratio of synthetic acceleration determined from unfiltered and filtered data was calculated to discriminate between locomotive and daily-living activities⁵⁽⁶⁾. Physical activity levels were measured in metabolic equivalents (METs) using an algorithm and expressed as exercise units (Ex), which were obtained by multiplying the intensity of physical activity (METs) by the duration of activity (h)⁶⁾. We supplied a procedure manual showing how to use the activity meter, including procedures to properly attach the activity meter to the waist belt and underwear pocket, and instructed the participants to wear it continuously for a week. Follow-up telephone assessments were performed every three days to address problems or questions related to the device. Data obtained during inactivity periods of ≥ 60 min, considered non-wearing time, were discarded³⁾, and valid data were extracted using the “activity meter application” provided with the device.

E Statistical analysis

The normality of the data was examined using the Shapiro-Wilk test, and representative values for the variables were determined. Univariate and multivariate regression analyses were performed to identify the factors associated with locomotor activity and ADL levels. The objective variables were locomotor and daily-living activities, and the explanatory variables were age, sex, care level, service type, family composition, pain intensity, sleep quality (AIS), physical function (SPPB), cognitive function (MMSE-J), mental function (GDS), and ADL performance (FIM). Explanatory variables were selected based on previous research findings⁹⁾⁻¹⁴⁾ and the authors' clinical empirical knowledge. To avoid overfitting, variables

that were significant in the univariate analysis were injected by increasing the number of explanatory variables and extracting more relevant factors from the multiple regression analysis, and a stepwise method of variable selection was used. The correlation coefficients for the level of care, SPPB, and FIM exceeded 0.9, indicating a risk of multicollinearity. To address this, three models were created: care level, SPPB, and FIM models, each incorporating one of these variables at a time.

All statistical analyses were performed using SPSS Ver. 29 (IBM Corp., Armonk, NY), with a significance of <0.05 for all tests.

F Ethics

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. The research plan was approved by the institution's Ethical Review Board (approval number: H30-018; approval date: September 29, 2019). Participants were informed about the study's purpose, and consent to participate was obtained from all participants.

III Results

Among the 60 individuals who provided consent, six were excluded owing to missing data, and 54 were included in the analysis. The participant characteristics and functions are shown in **Table 1**. The mean age of the participants was 77.5 years, with 44.4 % being men. The most common care need level was 3, and service types (in-home vs. daycare rehabilitation) were evenly distributed. The median values for pain intensity, AIS, SPPB, and MMSE-J scores were 2, 4, 5, and 26.5, respectively. Physical function was low, and cognitive function was high. The mean GDS and FIM were 5.4 and 89.2, respectively. The mean locomotive and daily-living activities were 0.17 METs*h/day and 1.34 METs*h/day; 0.19 METs*h/day and 1.44 METs*h/day for men; and 0.16 METs*h/day and 1.27 METs*h/day for women, respectively. Participants in in-home rehabilitation had 0.13 METs*h/day and 1.12 METs*h/day, while participants in daycare rehabilitation had 0.22 METs*h/day and 1.63 METs*h/day, with the latter showing significantly higher results.

Table 1 Characteristics and activity levels of the participants

Participant attribute		<i>n</i> = 54
Age	Mean (SD)	77.5 (6.8)
Sex	Men/women <i>n</i> (%)	24/30 (44.4/55.6)
Care level	Median (IQR)	3 (2.25-4)
1	<i>n</i> (%)	4 (7)
2		10 (19)
3		22 (41)
4		17 (31)
5		1 (2)
Service type	In-home/daycare <i>n</i> (%)	25/29 (46/54)
Pain intensity	Median (IQR)	2 (1-2)
AIS	Median (IQR)	4 (2.25-5.76)
SPPB	Median (IQR)	5 (2-6.75)
MMSE-J	Median (IQR)	26.5 (25-29)
GDS	Mean (SD)	5.4 (2.9)
FIM total	Mean (SD)	89.2 (18.5)
FIM locomotion	Mean (SD)	4.7 (1.4)
Locomotion type	Walk/wheelchair <i>n</i> (%)	40/14 (74.1/25.9)
	Mean (SD)	0.17 (0.13)
Locomotive activity (METs* <i>h</i> /day)	Men	0.19 (0.16)
	Women	0.16 (0.10)
	In-home	0.13 (0.11)
	Daycare	0.22 (0.13)
	Mean (SD)	1.34 (0.65)
Daily-living activity (METs* <i>h</i> /day)	Men	1.44 (0.59)
	Women	1.27 (0.68)
	In-home	1.12 (0.61)
	Daycare	1.63 (0.59)

SD, standard deviation ; IQR, interquartile range ; SPPB, Short Physical Performance Battery ; MMSE-J, the Japanese version of the Mini-Mental State Examination ; AIS, Athens Insomnia Scale ; GDS, Geriatric Depression Scale ; FIM, Functional Independence Measure ; METs, metabolic equivalent of task.

The analysis of factors associated with locomotor and daily-living activities using univariate and multivariate regression analyses is shown in **Table 2** and **Table 3**, respectively. Univariate regression analysis showed significant associations between locomotor activity and all factors except sex and service type. In multivariate regression analysis using the stepwise method, care level ($\beta = -0.452$) and GDS ($\beta = -0.395$) in the care level model ; SPPB ($\beta = 0.468$) and GDS ($\beta = -0.400$) in the SPPB model ; and FIM ($\beta = 0.443$) and GDS ($\beta = -0.448$) in the FIM model were extracted as associated factors. Univariate regression analysis revealed significant associations between ADL and participant characteristics, except for sex.

In multivariate regression analysis using the stepwise method, care level ($\beta = -0.519$) and AIS ($\beta = -0.467$) in the care level model ; SPPB ($\beta = 0.476$) and AIS ($\beta = -0.507$) in the SPPB model ; and FIM ($\beta = 0.423$) and AIS ($\beta = -0.588$) in the FIM model were extracted as associated factors.

IV Discussion

In this exploratory observational study, locomotive and daily-living activities were measured using an activity meter for the first time in community-dwelling older adults undergoing rehabilitation. We aimed to identify factors associated with these activities. Among healthy older adults in a previous study, the amount

Physical activity in community-dwelling older adults

Table 2 Factors associated with locomotive activity by univariate and stepwise multivariate regression analysis

Participant characteristic	Univariate		Multivariate								
			Care level model			SPPB model			FIM model		
	β	P	β	P	VIF	β	P	VIF	β	P	VIF
Age	-0.367	0.006		ns			ns			ns	
Sex	-0.150	0.279		-			-			-	
Care level	-0.718	<0.001	-0.452	<0.001	1.828		-			-	
Service type	0.265	0.052		-			-			-	
Family composition	-0.371	0.006		ns			ns			ns	
Pain intensity	-0.456	<0.001		ns			ns			ns	
AIS	-0.642	<0.001		ns			ns			ns	
SPPB	0.724	<0.001		-		0.468	<0.001	1.694		-	
MMSE-J	0.591	<0.001		ns			ns			ns	
GDS	-0.700	<0.001	-0.395	0.002	1.828	-0.400	<0.001	1.694	-0.448	<0.001	1.475
FIM total	0.697	<0.001		-			-		0.443	<0.001	1.475
FIM locomotion	0.519	<0.001		ns			ns			ns	
Locomotion type	0.414	<0.001		ns			ns			ns	
			Adjusted R ² = 0.585, DW = 1.749			Adjusted R ² = 0.604, DW = 1.799			Adjusted R ² = 0.607, DW = 1.686		

AIS, Athens Insomnia Scale ; SPPB, Short Physical Performance Battery ; MMSE-J, the Japanese version of the Mini-Mental State Examination ; GDS, Geriatric Depression Scale ; FIM, Functional Independence Measure ; VIF, variance inflation factor ; DW, Durbin-Watson ratio ; ns, not significant

Table 3 Factors associated with daily-living activity by univariate and stepwise multivariate regression analysis

Participant characteristic	Univariate		Multivariate								
			Care level model			SPPB model			FIM model		
	β	P	β	P	VIF	β	P	VIF	β	P	VIF
Age	-0.331	0.014		ns			ns			ns	
Sex	-0.130	0.348		-			-			-	
Care level	-0.792	<0.001	-0.519	<0.001	1.520		-			-	
Service type	0.334	0.014		ns			ns			ns	
Family composition	-0.281	0.039		ns			ns			ns	
Pain intensity	-0.481	<0.001		ns			ns			ns	
AIS	-0.770	<0.001	-0.467	<0.001	1.520	-0.507	<0.001	1.440	-0.588	<0.001	1.230
SPPB	0.756	<0.001		-		0.476	<0.001	1.440		-	
MMSE-J	0.636	<0.001		ns			ns			ns	
GDS	-0.770	<0.001		ns			ns			ns	
FIM	0.677	<0.001		-			-		0.423	<0.001	1.230
FIM locomotion	0.471	<0.001		ns			ns			ns	
Locomotion type	0.483	<0.001		ns			ns			ns	
			Adjusted R ² = 0.796 DW = 2.363			Adjusted R ² = 0.741 DW = 2.252			Adjusted R ² = 0.729 DW = 2.041		

AIS, Athens Insomnia Scale ; SPPB, Short Physical Performance Battery ; MMSE-J, the Japanese version of the Mini-Mental State Examination ; GDS, Geriatric Depression Scale ; FIM, Functional Independence Measure ; VIF, variance inflation factor ; DW, Durbin-Watson ; ns, not significant.

of locomotive and daily-living activities was 2.34 METs*h/day and 3.07 METs*h/day for men and 1.26 METs*h/day and 3.59 METs*h/day for women, respectively⁷⁾.

In comparison, locomotive and daily-living activities in our study participants were considerably lower. Locomotive activity was 8 % in men and 13 % in women compared to healthy older adults, suggesting that most participants may have stayed indoors and rarely engaged in mobile activities. This inactivity may be linked to the fact that more than half of the participants required moderate or high levels of care, potentially limiting their locomotive activities to those associated with rehabilitative interventions. When activity levels were examined separately for daycare and in-home rehabilitation, participants using daycare rehabilitation services showed significantly higher levels of both locomotive and daily-living activities compared to those using in-home rehabilitation. The higher activity levels in daycare rehabilitation are attributed to larger spaces, exercise equipment, and interaction with other users, which enhance motivation. In contrast, in-home rehabilitation is often limited to smaller spaces, resulting in lower activity levels. To improve activity levels, daycare rehabilitation programs can benefit from group activities and exercise equipment, while in-home rehabilitation should focus on setting small, individualized goals, monitoring progress, and fostering a sense of achievement to encourage continuous improvement.

Daily-living activity levels, though reduced, were 47 % in men and 35 % in women compared to healthy older adults, which was not as low as locomotive activity levels. This suggests that essential daily-living activities contribute to maintaining a baseline level of activity, although lower than that of healthy older adults.

Factors influencing physical activity were investigated to determine strategies for increasing the amount of activity among older adults receiving community rehabilitation. Multivariate regression analysis showed that the SPPB, care level, and the FIM were associated with locomotive and daily-living activities. Physical activity has been shown to correlate with physical

function in healthy older adults⁹⁾¹⁰⁾, and this relationship also applies to older adults undergoing community rehabilitation. Our results confirmed the importance of interventions aimed at maintaining and improving basic physical functions, such as balance, gait, and lower-limb muscle strength, within the context of community rehabilitation to enhance physical activity levels. Care level reflects the amount of time required for caregiving, while FIM assesses the degree of ADL independence. Since both metrics are indicative of ADL independence, they were collectively defined as such in this study.

In healthy older adults, an inability to perform ADLs has been shown to negatively impact physical activity, resulting in a more sedentary lifestyle¹⁴⁾. Similarly, our results suggest that ADL dependency significantly reduces locomotive and daily-living activities, even among older adults in need of care who are undergoing rehabilitation. Although community rehabilitation programs already incorporate interventions to improve physical function and ADL independence, the amount of locomotive activity remains low. For those who can walk, methods to promote walking habits outside of rehabilitation interventions should be considered. For individuals requiring assistance to walk, alternative activities should be introduced. For instance, lower limb strength training, such as squats, is commonly used in both daycare and in-home rehabilitation as an alternative to walking to improve activity levels. Daycare rehabilitation allows for higher-intensity training using exercise equipment, promoting muscle strengthening. In contrast, in-home rehabilitation adapts to space limitations by adjusting the intensity and load of exercises to suit the home environment. For older individuals unable to walk, increasing daily-living activities is crucial. Collaborating with therapists and caregivers to identify activities and extend the time spent on them can help compensate for the lack of walking. This approach can improve overall activity levels, making it an effective intervention for increasing total activity. Multivariate regression analysis showed that overall ADL independence had a greater impact on the amount of ADL than mobility-specific independence. This find-

ing highlights the importance of improving overall ADL independence rather than focusing on walking or wheelchair mobility. To further increase ADL levels, it is necessary to consider basic ADLs and other activities.

Engagement in desired activities has been shown to improve ADL abilities among older residents in long-term care facilities²⁴. Similarly, interventions that encourage community-dwelling older adults in need of care to engage in activities they find enjoyable may improve their ADL abilities and activity levels. This can involve discussions with older adults about their hobbies or past interests and supporting them in incorporating these activities into their daily routines whenever possible. For physical activities, setting small, achievable goals and providing methods to track progress can further motivate individuals and foster a sense of independence to engage in these activities.

In this study, the GDS and AIS were independently associated with locomotive and daily-living activities, respectively. These findings were obtained by categorizing the physical activity of community-dwelling older adults requiring long-time care into locomotor and daily-living components. Depression is a common condition among older adults²⁵, often associated with poor health behaviors and increased mortality risk²⁶. Among older adults requiring long-term care, depressive symptoms were associated with reduced locomotive activity. This aligns with previous findings that depressive symptoms are associated with lower physical activity levels in both healthy older adults¹² and those requiring nursing care.

Sleep disturbances are another prevalent issue, with 36.2 % of older community-dwelling adults reporting subjective insomnia and daytime sleepiness affecting their daily lives²⁷. Poor sleep quality has been associated with low daytime physical activity in healthy older adults¹³. Similarly, older adults requiring long-term care who experience poor sleep quality demonstrate lower ADL activity levels during the day. For community-dwelling older adults undergoing rehabilitation, it is essential to examine and address depressive symptoms and sleep disturbances when physical

activity levels are low. Medical interventions for depression and sleep disorders can improve these symptoms, thereby increasing physical activity levels. Non-pharmacological therapies, such as cognitive behavioral therapy (CBT), have demonstrated effectiveness in managing depressive symptoms and sleep disorders in older adults²⁸⁾²⁹. Incorporating psychological approaches like CBT into daycare and home rehabilitation programs could help improve these conditions in older individuals receiving community rehabilitation. Exercise therapy has also been shown to be effective²⁸⁾²⁹, which further emphasizes the bidirectional relationship between depressive symptoms, sleep disorders, and physical activity levels in older adults. Daycare rehabilitation offers opportunities for more intensive training through group exercise and the use of specialized exercise equipment. In contrast, in-home rehabilitation provides individualized programs suited to the limitations of the home environment. These approaches can increase activity levels, which may, in turn, improve depressive symptoms and sleep quality.

This study's cross-sectional design limits the ability to determine causal relationships among the observed parameters. Our findings were discussed based on previous studies, but the small sample size of this exploratory study limits their immediate generalizability. Additionally, differences in the types of rehabilitation services provided, combined with the inclusion of participants with varying activity levels within the same care category, may have introduced selection bias and reduced validity. Addressing these issues through a more rigorous review of participant selection criteria will be important in future studies. Despite these limitations, this study introduces valuable insights by categorizing physical activity into locomotive and daily-living activities. The findings suggest that increasing daily-living activities should be a priority for older individuals requiring long-term care who exhibit extremely low levels of locomotive activity. Prospective cohort studies with larger sample sizes are warranted to confirm these findings.

V Conclusions

The amount of physical activity, especially locomotive activity, was notably low in community-dwelling older adults undergoing rehabilitation. Physical function and ADL performance were associated with both locomotive and daily-living activities. Additionally, depressive symptoms were linked to reduced locomotive activity, while poor sleep quality was associated with lower ADL performance. These findings highlight the need for tailored rehabilitation programs

aimed at increasing physical activity in older adults receiving long-term care.

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Declaration of conflicting interests

The authors confirm that there is no conflict of interest.

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