

Interaction between Caregiving Ability and Home Discharge Using Severity Classification upon Discharge

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Abstract

Background: The interaction between self-care and caregiving ability in home discharged stroke patients is unclear. **Purpose:** This study investigates the interaction between caregiving ability and individual self-care activities for post-stroke patients upon home discharge based on their motor-Functional Independence Measure (m-FIM) score. **Methods:** A total of 2626 stroke patients registered in the Japanese Rehabilitation Database were retrospectively analyzed. Extracted data were divided into three groups based on the m-FIM score at discharge and classified into two groups based on their discharge destination (home discharge, non-home discharge). After the data were modified as mean-centered values, a hierarchical multiple regression analysis evaluated the change in variance amount (ΔR^2) using discharge destination as the dependent variable. Model 1 used two independent variables (Rankin Scale and cognitive FIM score), model 2 used two independent variables (caregiving ability and individual self-care), which were added to model 1, and model 3 used an interaction term value, which was added to model 2. Furthermore, a simple slope analysis was performed for these interaction effects. **Results:** The ΔR^2 exhibited six and five self-care items in the moderate and mild groups, respectively. The interaction was significant on simple slope analysis in the moderate group for six self-care items (except dressing upper body, toileting, and bowel management) and in the mild group for three self-care items, including dressing upper body, bladder management, and climbing stairs). **Conclusion:** This study suggests the need for intervention, especially bladder management and single-foot standing ability during step climbing, in stroke patients discharged to home. In addition, caregiving ability is one of the factors that should be considered in mild group.

Keywords

Interaction, Stroke, FIM, Discharge, Caregiving Ability

1. Introduction

Stroke is a sudden and unpredictable disease that causes various long-term symptoms and post-stroke disabilities [1]. Stroke patients have various functional disabilities, of which gait and activities of daily living (ADL) disturbances are the most common [2] [3]. Hence, more than half the stroke patients need to be partially or totally assisted by others [4] [5] or family members as caregivers [6] in ADL after discharge. Therefore, caregiving ability and independence level of ADL are essential factors for determining home discharge [6] [7]. On the other hand, caregivers of stroke patients, who provide them nursing care at home, also experience various physical, mental, social, and economic problems that may affect their quality of life [5] [8]. Furthermore, in previous studies, only half of the caregivers were confident about caring for stroke patients, despite their knowledge about stroke-related nursing care [9] [10]. Owing to the high level of proficiency in nursing care skills always required, the stress on the caregivers is higher than that on the stroke patients themselves, and its trends that this stress does not decrease much over the years [11] [12]. This caregiver stress accounts for moving post-stroke patients from home to a nursing facility [13] [14]. Moreover, the dependence level of self-care negatively impacts families' decisions for home discharge, and families prefer high levels of self-care independence in post-stroke patients at home discharge. Despite the extensive literature available on the relationship between ADL and caregiving ability upon home discharge, the interaction between caregiving ability and improvements in individual ADL has not been sufficiently elucidated in stroke patients based on severity classification of paralysis. Interventions related to ADL could differ depending on the existence of an interactive relationship between ADL and caregiving ability. Therefore, to evaluate the interactions between ADL and caregiving ability that could lead to a higher possibility of home discharge, it is important to clarify the existence of an interaction between caregiving ability and ADL.

This study aimed to investigate the interaction between caregiving ability and individual self-care activities for home discharge based on the motor-Functional Independence Measure (m-FIM) score.

2. Materials and Methods

2.1. Subject

The medical data of 6875 patients with stroke were extracted from the Japan Rehabilitation Database (JRD) in the stroke/recovery rehabilitation phase ward (January 2016 version, <https://square.umin.ac.jp/JARD/>). We used anonymized

observational data obtained in normal clinical settings. The need for informed consent was waived due to the retrospective and observational design of the study and the use of secondary data. The original data collection had been approved by the Ethics Committee of the Japanese Association of Rehabilitation Medicine (November 14, 2014). However, the committee did not issue an approval number.

2.2. Setting

A flowchart of the subject in this study is shown in **Figure 1** [15]. The inclusion criteria were as follows: age, 20 - 100 years; days from onset to admission, 20 - 200 days; and length of ward stay, 1 - 255 days. Similarly, all data were collected based on FIM at discharge, Rankin scale (RS) at discharge, the destination of leaving the hospital excepting incompletely filed data. The exclusion criteria were death, changing hospital due to sudden turn for the worse and individuals

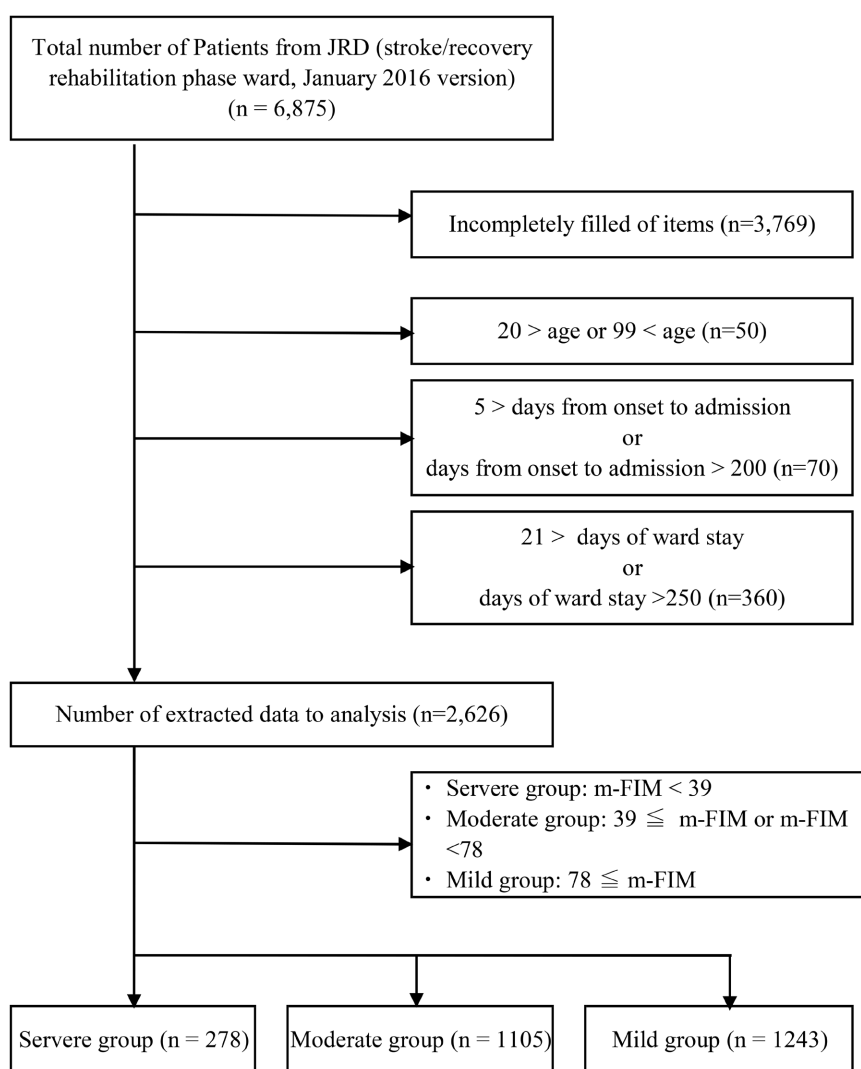


Figure 1. Flowchart of the data sampling with reason for exclusion. JRD, Japanese Rehabilitation Database. Figure partial modified from ref. [15].

who lived in nursing homes or other residential facilities prior to stroke onset and finally, the data of 2626 cases were analyzed. Extracted data was divided three groups based on discharged m-FIM score (severe: <39, moderate: more than 39 to fewer than 78, mild: more than 78). The FIM score is reported to have high reliability, validity, and prediction for outcomes concerning the ADL evaluation post-stroke; it consists of 13 m-FIM and 5 cognitive FIM (c-FIM) items, which are evaluated using seven levels [16]. Caregiving ability was defined by the number of people who were available to care for the patient, and was set using a 5-point ordinal scale: level 1, almost none; level 2, less than one person who is constantly available to provide care; level 3, equivalent to one person who is constantly available to provide care; level 4, more than one and less than two people who are constantly available to provide care; level 5, equivalent to more than two people who are constantly available to provide care. In this study, the destination after leaving the hospital was categorized as follows: home discharge, non-home discharge like nursing facilities, etc. The stroke type does not generally influence the prognosis [17] [18]. Therefore, this information was excluded from this study. Sex, the duration from the onset to hospital admission, the length of ward stay, the cognitive FIM score, and caregiving ability were set as the general items.

2.3. Statistical Analysis

2.3.1. Hierarchical Multiple Regression Analysis

First, all data were modified as mean-centered values to avoid multicollinearity among items. The mean-centering value was calculated by subtracting the mean from the raw value. Secondly, the evaluation of each self-care interaction was subsequently performed using hierarchical multiple regression. Hierarchical regression is the way that several regression models are built by adding variables to a previous model at each step. This method allows for the examination of the contribution above and beyond the first group of independent variables. In this study, this analysis used home discharge as the dependent variable in a prediction formula (model 1) using two items as independent variables (RS, c-FIM) to evaluate the influence of the control variables. Model 2 added two items as independent variables (caregiving ability and self-care) to Model 1. In the concept of interaction, the idea of a two-way effect is defined, as opposed to a causal one-way effect. It means that the influence of an independent variable on a dependent variable varied across the levels of a moderating variable. Individual self-care score of m-FIM at discharge was set as the moderating variable in this study [18] [19]. Consequently, a prediction formula, namely “model 3,” added an interaction term value to model 2.

2.3.2. Simple Slope Analysis

If an interaction were significant, a simple slope analysis was conducted following the method by Cohen & Cohen [19] and the Johnson-Neyman technique (JN technique) [20]. The simple slope method evaluates whether the influence of the

independent variable on the dependent variable is statistically significant when the adjustment variable takes a specific value, and it has been reported that the JN technique is an effective procedure for investigating the significance of the interaction, when the moderator value is continuous [19] [20]. Rather than testing for significance at fixed values of the moderator, the JN technique solves for the values of the moderator for which the effect of X on Y becomes or ceases to be significant. Moreover, it can explain, as a function of the moderator, the lower and upper bounds for the confidence bands estimating the effect of X on Y. A graph of the confidence bands makes it easy to see for which values of the moderator the effect of the focal predictor on the response is significant. The statistical significance level was set at $p < 0.05$. Statistical analyses were conducted using IBM SPSS version 20.0 (IBM Corp., Armonk, NY, USA), and the online software created by Preacher, Curran, & Bauer was used for simple slope analysis.

3. Results

3.1. General Overview

Data of 6875 stroke patients are registered on the JRD. Of these, the 4249 patients who failed to meet the inclusion criteria were excluded, and 2626 who met the criteria were ultimately included in this study. Overall, 1096 (41.7%) participants were female, the home discharge rate was 84.4%, and the median age was 69.3 years. The baseline characteristics of the subjects in each group and the results of comparisons between groups are presented in **Table 1**. The results showed significance in each group in terms of caregiving ability. In addition, all self-care items showed significance in the moderate group. However, almost of self-care items in the other two groups did not show much significance.

3.2. Simple Slope Analysis

Table 2 presents self-care that had significant changes in variance amount in the hierarchical multiple regression, except for the severe group. **Figure 2** illustrates the relationship between dependent and independent variables under a moderator of variation (mean \pm 1 SD). The simple slope analysis was significant for six self-care items in the moderate group (except dressing upper body, toileting, and bowel management) and three self-care items in the mild group (dressing upper body, bladder management, and climbing stairs). These groups had two self-care items in common: bladder management and climbing stairs. Moreover, caregiving ability interaction had a score of 1 - 2 (three to four people) in the moderate group and 0 - 1 (two to three people) in the mild group. Because of the limitation in evaluating continuous variables using the subtest for interaction influence, the region of significance and 95% confidence interval of the simple slope in each group were calculated. Then, the extracted variable of self-care was significant except grooming and dressing lower body in the mild group (**Figure 3**).

Table 1. Descriptive characteristics of the subject at discharge in each group and results of comparison between home discharge and non-home discharge.

a) Server group	Overall (n = 278)	Home discharge (n = 130)	Non-home discharge (n = 148)
Age	76.14 ± 9.60	74.2 ± 10.43	77.84 ± 8.48**
Female, %, (n)	46.4 (n = 129)	44.6 (n = 58)	45.0 (n = 71)
Days form onset to admission	40.70 ± 14.73	41.05 ± 14.83	40.39 ± 14.69
Days of ward stay	127.28 ± 40.04	131.35 ± 42.24	123.7 ± 37.79
Caregiving ability	2.44 ± 1.02	2.83 ± 0.93	2.10 ± 0.97**
Rankin scale	4.09 ± 0.74	3.93 ± 0.77	4.22 ± 0.68**
m-FIM	26.78 ± 7.56	27.25 ± 7.72	26.36 ± 7.43
c-FIM	15.88 ± 6.69	15.98 ± 6.51	15.79 ± 6.86
Eating	4.07 ± 1.58	3.99 ± 1.72	4.14 ± 1.45
Grooming	2.63 ± 1.40	2.59 ± 1.42	2.66 ± 1.39
Bathing	1.34 ± 0.60	1.34 ± 0.55	1.34 ± 0.64
Dressing upper body	2.00 ± 1.01	2.09 ± 1.06	1.92 ± 0.97
Dressing lower body	1.52 ± 0.80	1.58 ± 0.89	1.47 ± 0.70
Toileting	1.63 ± 0.89	1.72 ± 1.06	1.55 ± 0.71
Bladder management	1.71 ± 1.02	1.72 ± 1.04	1.70 ± 1.01
Bowel management	2.24 ± 1.59	2.30 ± 1.58	2.18 ± 1.61
Gait/Wheelchair	1.77 ± 1.20	1.84 ± 1.21	1.71 ± 1.19
Climbing stairs	1.10 ± 0.42	1.13 ± 0.44	1.08 ± 0.40
b) Moderate group	Overall (n = 1105)	Home discharge (n = 889)	Non-home discharge (n = 216)
Age	71.83 ± 11.77	70.87 ± 11.98	75.78 ± 9.96**
Female, %, (n)	44.6 (n = 493)	44.1 (n = 392)	46.8 (n = 101)
Days form onset to admission	36.47 ± 14.74	36.43 ± 14.93	36.62 ± 13.95
Days of ward stay	116.07 ± 42.97	115.05 ± 43.26	120.25 ± 41.59
Caregiving ability	2.32 ± 0.94	2.46 ± 0.90	1.73 ± 0.91**
Rankin scale	3.14 ± 0.85	3.07 ± 0.85	3.40 ± 0.80**
m-FIM	63.28 ± 10.79	64.60 ± 10.37	57.83 ± 10.83**
c-FIM	25.07 ± 6.42	25.60 ± 6.35	22.89 ± 6.28**
Eating	6.00 ± 0.97	6.04 ± 0.96	5.85 ± 1.01**
Grooming	5.49 ± 1.21	5.57 ± 1.19	5.14 ± 1.25**
Bathing	3.78 ± 1.24	3.88 ± 1.22	3.37 ± 1.21**
Dressing upper body	5.13 ± 1.49	5.28 ± 1.44	4.52 ± 1.55**
Dressing lower body	4.86 ± 1.64	5.04 ± 1.58	4.15 ± 1.71**

Continued

Toileting	5.29 ± 1.30	5.40 ± 1.23	4.81 ± 1.46**
Bladder management	5.31 ± 1.74	5.47 ± 1.69	4.69 ± 1.81**
Bowel management	5.43 ± 1.39	5.55 ± 1.32	4.95 ± 1.56**
Gait/Wheelchair	4.65 ± 1.65	4.69 ± 1.66	4.50 ± 1.61**
Climbing stairs	2.67 ± 1.78	2.80 ± 1.80	2.15 ± 1.62**
c) Mild group	Overall (n = 1243)	Home discharge (n = 1197)	Non-home discharge (n = 46)
Age	65.51 ± 13.29	65.24 ± 13.35	72.39 ± 9.20**
Female, %, (n)	38.1 (n = 474)	37.8 (n = 452)	47.8 (n = 22)
Days form onset to admission	32.02 ± 13.94	31.91 ± 13.97	34.87 ± 13.14**
Days of ward stay	83.62 ± 38.95	83.14 ± 38.78	95.96 ± 41.70**
Caregiving ability	2.19 ± 0.95	2.22 ± 0.94	1.37 ± 0.68**
Rankin scale	1.79 ± 0.88	1.78 ± 0.88	2.02 ± 1.02**
m-FIM	85.14 ± 4.12	85.19 ± 4.10	83.85 ± 4.36**
c-FIM	30.94 ± 4.76	31.12 ± 4.64	26.24 ± 5.25**
Eating	6.87 ± 0.37	6.87 ± 0.37	6.93 ± 0.25**
Grooming	6.86 ± 0.41	6.87 ± 0.40	6.67 ± 0.67**
Bathing	6.21 ± 0.98	6.22 ± 0.98	5.93 ± 1.02**
Dressing upper body	6.90 ± 0.36	6.90 ± 0.35	6.80 ± 0.54**
Dressing lower body	6.87 ± 0.37	6.87 ± 0.36	6.72 ± 0.58**
Toileting	6.78 ± 0.43	6.78 ± 0.43	6.72 ± 0.46**
Bladder management	6.88 ± 0.45	6.88 ± 0.43	6.74 ± 0.85**
Bowel management	6.71 ± 0.55	6.72 ± 0.53	6.57 ± 0.83**
Gait/Wheelchair	6.12 ± 1.49	6.11 ± 1.51	6.37 ± 1.02**
Climbing stairs	5.59 ± 1.42	5.59 ± 1.42	5.48 ± 1.28**

Item with bold and italic; showing a significant by hierarchical multiple regression analysis. *p < 0.05, **p < 0.01.

Table 2. ΔR^2 value of hierarchical multiple regression analysis for individual self-care in each group.

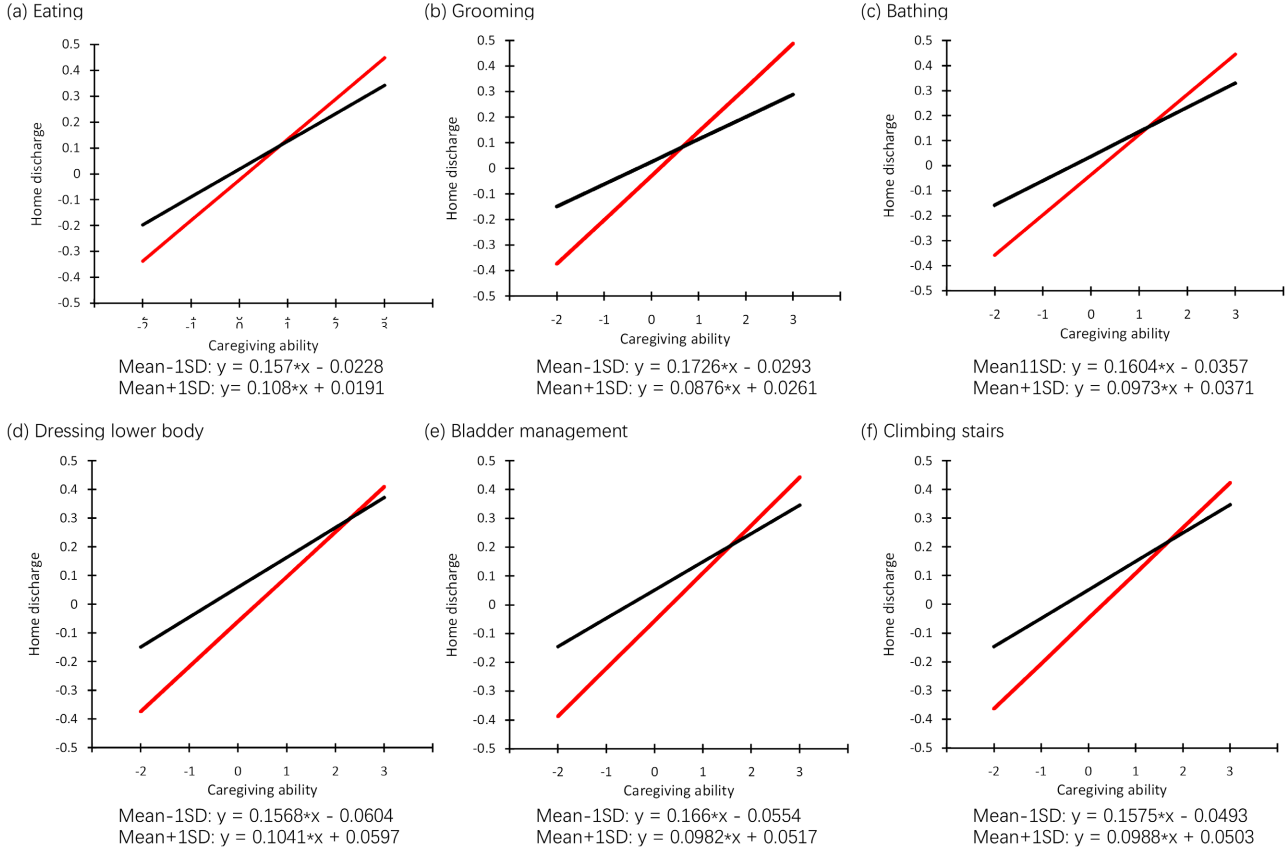
	Severe group (n = 278)	Moderate group (n = 1105)	Mild group (n = 1243)
Eating	-	0.004**	-.**
<i>Grooming</i>	-	0.011**	0.017**
Bathing	-	0.006**	-.**
Dressing upper body	-	-.**	0.006**
<i>Dressing lower body</i>	-	0.004**	0.011**
Toileting	-	-.**	-.**

Continued

Bladder management	-	0.007**	0.007**
Bowel management	-	_**	_**
Gait/Wheelchair	-	_**	_**
Climbing stairs	-	0.005**	0.003**

Results with bold and italic; showing non-significant by simple slope analysis. ΔR^2 : the change in variance between model 2 and model 3. * $p < 0.05$, ** $p < 0.01$.

(A) Moderate group



(B) Mild group

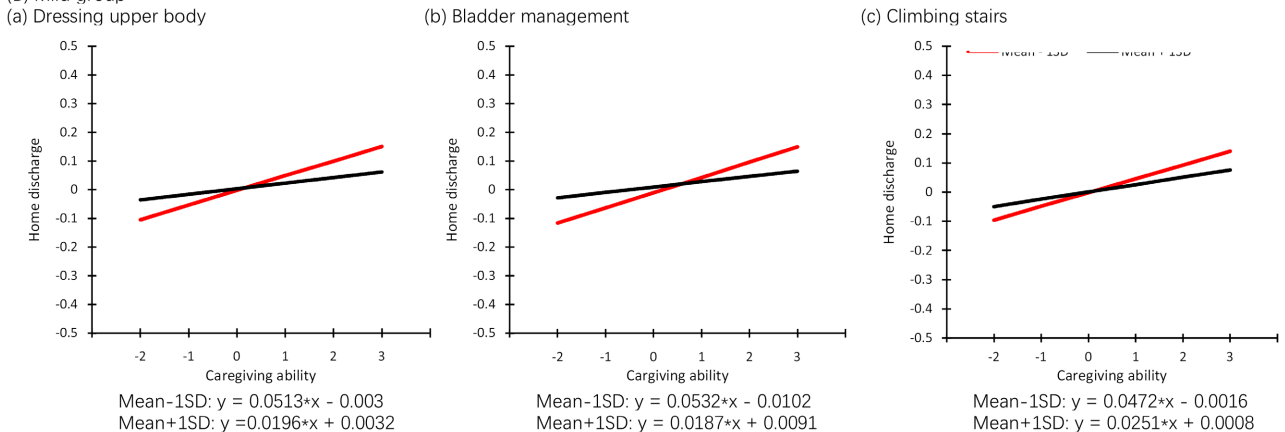


Figure 2. Interaction plots of caregiving ability predicting home discharge outcomes under each self-care as moderator factor. Black line; Mean + 1SD, Red line; Mean – 1SD. SD; standard deviation.

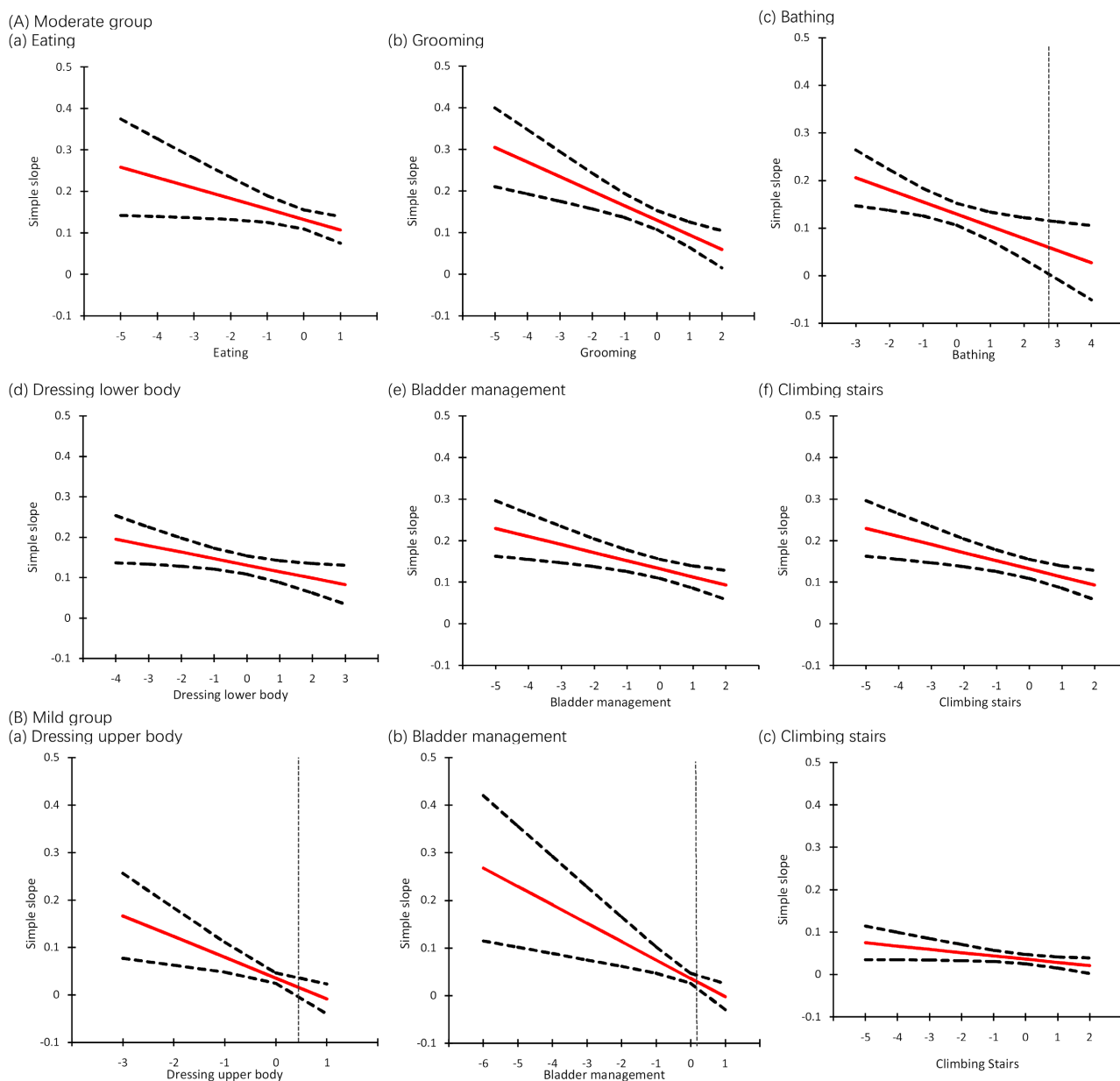


Figure 3. A region of significance and 95% confidence band of Simple slope after mean-centering. Center line with red; prediction coefficient of simple slope, up and down curve hatched line with black; 95% confidence interval that can be used to infer statistical significance. Vertical hatched lines with gray; upper or lower confidence band crosses the zero-line and they represent the boundary between areas where the slope is significantly areas where the slope is statistically not significant. Horizontal axis; range is from minimum to maximum of each self-care.

4. Discussion

This study investigated the interaction between self-care and caregiving ability in stroke patients based on the m-FIM score at discharge using multi-facility data (JRD). The main finding suggested that self-care in the mild and moderate groups revealed an interaction based on the discharge destination, implying that caregiving ability impacted home discharge differentially across self-care levels. Moreover, the common aspects of self-care that influenced home discharge were blad-

der management and climbing stairs.

In recent times, the number of in-home post-stroke patients has been increasing; thus, the need for caregiving is also increasing. However, as the age of caregivers and burden are also increasing, stroke patients tend to be obliged to be discharged to nursing homes. Thus, ADL independence level is important to continue living at home. A previous study reported that the average scores of m-FIM and c-FIM for stroke patients who could be discharged to their homes regardless of whether they were living alone or with their family was 66 - 78 and 26 - 28, respectively [21] [22]. Both average scores in this study were similar to those of previous studies, except for those in the severe group. Additionally, the home discharge rate was also close to that of previous studies.

The severe group did not reveal an interaction between self-care and caregiving ability upon home discharge in this study. Compared with the other groups, most tasks in the severe group were at complete dependence level, which is defined as total or maximum assistance in taking care, except for eating. Moreover, the m-FIM score of self-care was not significant by comparison between groups based on discharge destination. This may be because the self-care level does not have a strong relationship with home discharge in severe cases, and discharge depends on caregiving ability.

Upper limb function and sitting balance are important factors in self-care post stroke. The usefulness of the upper limbs is related to improving ADL [23] [24] [25]. Moreover, it is necessary not only to improve the functioning of upper limbs for taking food to the mouth, but also to improve the grip functioning for handling the dishes and cutlery corresponding to the other upper limb's action while eating. Besides this, in dressing, sensitive control of the upper limbs is needed to put the arm through a sleeve or put feet through a piece of clothing. If such actions are not controlled, spills or disheveled clothes might happen, and caregiving will be required for adapting to these problems. Therefore, upper limb function is critical for conducting self-care.

In addition, stability of sitting and standing influence the control of the unaffected/affected or bilateral upper limbs when doing self-care, and patients with stroke are often cared for when they are in a seated position. Trunk function is relevant to balanced control of the center of gravity and for upper limb actions in ADL [26] [27]. Moreover, it impacts advanced applied activities like gait. Hence, it is assumed that performance of affected upper limbs and trunk function in self-care impacts affects not only the quantity but also the quality of other activities.

Self-care, which had an interaction in this study, involves basic activities in daily life and requires frequent repetitions. For instance, grooming consumes approximately 20% of daily time [28] [29] [30]. Caregivers have to deal with such self-care at home, and it is possible that they are forced to spend time to adapt to varied care challenges. Such time constraints account for one of several elements of the caregiving burden. Hence, it is assumed that the self-care ability of the patients exhibits an interaction with caregiving ability upon home discharge.

However, these interactions were more evident in the moderate group than in

the mild group. The characteristics of the moderate group were significant among group comparison, and their independence levels were moderate to minimal. Caregivers spent more time caring for this group, which caused their burden to increase [31]. Therefore, it is assumed that self-care interaction depends on the caregiver's ability, in the case of home discharge.

4.1. Bladder Management

Daily bladder movement frequency in elderly people tends to be greater, while void volume at one time is less compared to that in younger people. Chronic intestinal constipation is a common bowel symptom in post-stroke patients, while diminished frequency is another reported bowel dysfunction [32] [33] [34]. Further, overactive bladder is a common stroke symptom [27], with a frequency of eight or more times in 24 hours. Such complex sphincter impairment related disabilities have a negative influence on their quality of life (QOL) [35] [36]. The increased burden on caregivers for patients with sphincter impairment at home made them feel entrapped, further impacting their health [37]. Thus, sphincter dysfunction impacts the ADL performance and increases the burden on caregivers [38] [39]. In this study, bladder management level was independent to minimal assist. The frequency of bladder management failure was defined as once per day to never (zero); that is, the frequency of once-daily was 2 - 6 times per week. Moreover, modified independence (level 6) was defined as taking more time than normal. Caregivers understand that the failure risk of bladder management is high in such situations, and that they need to pay constant attention to avoid the risk; this accounts for the psychological burden on the caregivers.

Pelvic floor muscles (PFM) have a relation with not only the bladder sphincter but also with the trunk function; thus, trunk function has is relevant to ADL. Interaction of trunk function with other self-care activities leads to improved bladder management, and the burden on caregivers is reduced. Therefore, sphincter independence is an important factor in caregivers' QOL, and it was assumed that bladder management was related to the interaction with the caregiving ability.

4.2. Climbing Stairs

The home setting is critical for home discharge in post-stroke patients. Adjustments in home setting comprising layout change, a threshold with no step, and slip-resistant flooring may have to be ensured [38]. When post-stroke patients live at home, in addition to walking, they encounter steps and differences in floor levels, increasing the risk of falling. In this study, the minimum required level of climbing stairs was identified as above level 3 to 4. This situation strains the caregivers as it takes great effort to ensure that the stroke patient does not fall owing to even a slight step. In addition, the knee joint has been reported to be highly loaded when climbing the stairs, with an average peak resultant force, in percent of body weight, three times higher compared with gait [40], indicating that the caregiving burden is greater while climbing stairs. Moreover, falling and

fall-related injuries are reported to be serious problems for home-dwelling stroke patients [41]. Thus, it requires greater direct caregiving as well as advanced techniques compared with other self-care activities. Moreover, falling is a negative factor and is assumed to lead to negative feelings, such as perceived rejection by family members about home discharge. Therefore, it is assumed that the independence level of climbing stairs impacted caregiving ability and home discharge.

Climbing stairs is most difficult activity for post-stroke. For this reason, rehabilitation intervention toward discharge is mainly gait training. It is assumed that an interaction climbing stairs in this study does not require performing that activity perfectly, and single-foot standing ability while climbing stairs is important to navigate a small step in the home.

5. Conclusions

In this study based on discharged m-FIM score, patients were classified into three groups, and then the interaction of self-care and caregiving ability on the discharge destination was investigated. Self-care interaction was not observed in the severe group, and was mainly observed in the moderate group, according to the analysis of JRD data. In addition, bladder management and climbing stairs had similar interactions in the moderate and mild groups. Moreover, caregiving ability interaction in mild group showed more influence than moderate group.

A limitation to this study was that home-modification planned after discharge (e.g., layout change, barrier-free) was not considered in setting the control variables for the three groups. Hence, future research should investigate an interaction based on hierarchy, using home-modification as a variable, with discharge m-FIM score.

Therefore, this study's findings suggest that there is a need not only for gait training but also for intervention for single-foot standing ability to get over a small step in the home to facilitate home discharge of stroke patients. Moreover, caregiving ability was suggested to be an important factor in the mild group. Future research should be conducted on three-way interaction based on hierarchy, with discharge m-FIM score, using a value as home-modification, and should further test and discuss the influencing factors.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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