

ORIGINAL ARTICLE

Association between Caregivers' Fear of Post-fracture Patients Falling and a Decline in Patients' Activities

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Objectives: To evaluate caregivers' fear of post-fracture patients falling, we previously developed the Caregivers' Fear of Falling Index (CFFI). In this study, we investigated the relationship between patient performance in activities of daily living (ADLs) and CFFI. **Methods:** We surveyed 55 patients receiving home-visit rehabilitation after fall-related fracture and their primary caregivers. Participants (patient and caregiver pair) were divided into two groups based on patient performance in basic ADLs (BADLs) and instrumental ADLs (IADLs). ROC analysis was conducted to assess the usefulness of CFFI and Falls Efficacy Scale-International (FES-I) in determining declines in performance in BADLs and IADLs. Multivariate logistic regression analysis was performed to examine the association between CFFI and declining performance in BADLs and IADLs. **Results:** ROC analysis showed that CFFI exhibited a higher accuracy than FES-I (AUC: 0.73 in BADLs, 0.77 in IADLs) as an indicator of reduced ADL performance. Multivariate logistic analysis adjusted for age, sex, and physical function showed that CFFI was associated with a decline in patients' performance in IADLs (odds ratio, 0.92; 95% confidence interval, 0.85–0.99). **Conclusions:** Caregivers' fear of post-fracture patients falling was associated with a decline in patients' performance in IADLs. These findings may serve as a guide for supporting caregivers of post-fracture patients.

Key Words: basic activities of daily living; caregiver; fear of falling; instrumental activities of daily living; post-fall fracture

INTRODUCTION

In the elderly, fall-related fractures have multifaceted impacts on their physical function and functional ability. The fractures for which falls are the most common mechanism of injury are hip fractures (over 75%),¹ upper extremity fractures (97%), wrist fractures (100%),² and spinal fractures (at least 30%).³ Among these, hip fractures result in reduced mobility⁴ and constitute a significant consequence for the

elderly.⁵ Therefore, hip fractures frequently require long-term rehabilitation using care insurance. Previous studies reported that 17%–65% of patients with hip fractures showed a decrease in basic activities of daily living (BADLs) at 3 months postoperatively,^{6–8} and 14%–57% of patients continued to exhibit ADL impairment at 1 year postoperatively.^{9–14} Furthermore, 13%–18% of these patients required walking assistance.^{11,15} For instrumental activities of daily living (IADLs), 66%–82% of patients with hip fractures required

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assistance at 3 months postoperatively,^{6,16} and 43%–71% still required assistance at 1 year postoperatively.^{9,10,16} Furthermore, in the case of the elderly, hip fractures are not the only fractures that affect ADL performance. In a study of patients with spinal fractures, Gosch *et al.*¹⁷ reported that 69% of patients had achieved independence in BADLs at 4 months after discharge. In another study of spinal fractures in the elderly, BADLs were reduced at 1 year after spinal fracture with a 24% decrease mobility.¹⁸ Although BADLs in patients with upper extremity fractures do not decline as significantly as those with lower extremity fractures or spinal fractures, the performance capabilities of patients with upper extremity fractures also show clear declines.^{19,20} In addition, there are numerous fall risk factors present in patients with wrist fractures, and many patients are at high risk of recurrent falls.²¹ In elderly patients who show a decline in ADLs after a fall-related fracture, factors that contribute to this decline include advanced age, impaired physical function, and cognitive decline.^{10,14,22}

In the care of elderly patients with fractures, primary caregivers are likely to fear that the patients under their care may suffer further falls while performing activities. In Japan, 66% of primary caregivers are family members who live with care recipients, many of whom are spouses or children.²³ A previous study of patients with hip fracture and their primary caregivers showed that the fear of further falls was higher in primary caregivers than in the patients themselves.²⁴ Furthermore, it has been suggested that caregivers' fear of further falls in post-fracture patients can affect the care burden of the primary caregiver.²⁵ Therefore, understanding the concerns of primary caregivers in relation to post-fracture patients suffering further falls is important for the welfare of patients receiving care at home.

When compared with a patient's own fear of falling, the fear held by the caregiver may have equal or greater potential to limit the patient's performance in BADLs and IADLs. To date, the lack of a common indicator to assess these factors has hindered investigations into their interrelationships. Therefore, in a previous study, we identified key items necessary for evaluating caregivers' fear of post-fracture patients falling and developed an evaluation index.²⁶ In the current study, we used this evaluation index to investigate the relationship between caregivers' fear of post-fracture patients falling and patients' performance in daily living. Currently, it remains unclear whether differences in fracture sites affect the caregivers' fear of post-fracture patients falling. During post-fracture recovery, the risk of further fractures caused by recurrent falls is elevated regardless of the initial fracture

site.²⁷ Therefore, it is possible that the actual occurrence of a fall, rather than the specific fracture site, could influence the concerns of caregivers in relation to post-fracture patients suffering further falls. This study aimed to clarify the influence of caregivers' fear of post-fracture patients falling on patients' ADL performance, encompassing various fracture sites.

MATERIALS AND METHODS

This cross-sectional study was conducted in accordance with the Declaration of Helsinki. The study protocol was reviewed and approved by the Institutional Review Board of the International University of Health and Welfare (No. 20-Im-027).

Panel of Participants

Participants included patients with a history of fall-related fractures and their primary caregivers. All patients met the following inclusion criteria: 1) past history of fall-related fracture of an upper extremity, a lower extremity, the spinal column, rib, or pelvis; 2) aged 65 years or older at the time of fracture; 3) less than 5 years since the time of the fracture to entry into the study; 4) the patient is not bedridden; 5) the primary caregiver was the spouse or a child of the patient and lived with the patient; 6) the primary caregiver showed no evidence of cognitive impairment; 7) the primary caregiver showed no evidence of psychiatric disorders (e.g., depression or anxiety neurosis); 8) all participants provided written consent to participate (after receiving verbal and written explanation of the study); and 9) receiving home-visit rehabilitation services during the study. Home-visit rehabilitation is one of the in-home rehabilitation services implemented under the long-term care insurance system in Japan. It is broadly categorized into home-visit rehabilitation and commuting rehabilitation services. The home-visit rehabilitation program is based on a comprehensive approach in the home environment and includes resistance training, gait exercises, and ADLs training, as necessary. In many cases, patients received one 40-min rehabilitation session per week. Data for this study were provided by International University of Health and Welfare Ichikawa Hospital, Ushiku Aiwa General Hospital, Home-visit Nursing Station Gratia, and Home-visit Nursing Station Ryugasaki. Subjects were evaluated from 1 July 2021 to 31 March 2023. The influence of fracture on patients' physical function may vary with the type, location, and severity of the fracture. However, it remains unclear whether caregivers' fear of patient falls varies according to

the type of fracture. Therefore, we included patients with lower extremity fractures and those with fractures involving other body parts. Primary caregiver surveys were conducted within 1 week of patient evaluation.

Measurement of Caregivers' Fear of Post-fracture Patients Falling

Caregivers' fear of post-fracture patients falling was assessed using the Caregivers' Fear of Falling Index (CFFI). The CFFI is determined from a self-rated questionnaire that measures the fear of falling among primary caregivers of patients with fall-related fractures. The CFFI questionnaire utilizes 20 assessment items that were identified during our previous research. These items include not only the patient's physical function and behavioral characteristics, but also the main caregiver's home environment and behavioral characteristics.²⁶⁾ Each assessment item was rated on a four-point scale: 1, not at all applicable; 2, not very applicable; 3, somewhat applicable; 4, applicable; maximum score of 80 points. Because the questionnaire was targeted specifically at the primary caregiver, the caregiver and patient were explicitly identified at the beginning of the questionnaire as follows: "This questionnaire asks about you and the patient (name)". As previously reported, the CFFI has good reliability with a Cronbach's alpha of 0.904. Furthermore, its validity is supported by a moderate correlation with the Falls Efficacy Scale-International (FES-I) ($r=0.432$).²⁸⁾

The FES-I is based on a self-administered questionnaire that asks patients to complete 16 items on a 64-point scale. The assessment items of the FES-I questionnaire encompass activities that are relevant to daily living and could potentially cause falls, such as taking a bath or shower, walking around the house, and getting in/out of a chair. As the respondents, the primary caregivers were asked to rate their confidence in the patients' ability to perform each of these activities. The FES-I can also be used to evaluate caregivers' fear of patients falling.²⁴⁾

Measurement of Post-fracture Patients' Performance in BADLs and IADLs

The Barthel Index (BI) was used to assess the performance of post-fracture patients in BADLs, whereas the Frenchay Activities Index (FAI) was used as a measure of IADLs. BI is based on performance in ten ADLs: feeding, dressing, transfers, grooming, toilet use, bathing, stair climbing, bowel control, bladder control, and mobility. Each item is rated on a scale of: "Independence", "Partial assistance", and "Assistance", and the scores are summed to give a total

score ranging from 0 to 100 (0, complete dependence; 100, complete independence). A score of 85 is considered to be the threshold for the transition to independence from requiring assistance.²⁹⁾ FAI is based on 15 items within the broad categories of domestic chores, hobbies, and occupation. FAI scores range from 0 to 45, with higher scores indicating that more IADLs are being performed. Previous studies have shown that FAI has good reliability and validity.^{30,31)}

Other Variables

Patient data were obtained by rehabilitation personnel at each facility: age, sex, relationship with caregiver, long-term care-level, fracture site, comorbidities (hypertension, stroke, neurological degenerative disease, diabetes mellitus, malignant disease), Montreal Cognitive Assessment-Japanese version (MoCA-J), and Short Physical Performance Battery (SPPB). The long-term care level referred to the degree of care required of the care service, based on the assessment criteria of Japan's long-term care insurance system. The long-term care level is divided into seven levels: requiring support 1 and 2, and requiring long-term care 1 to 5, depending on the level of care needed. In MoCA-J, a score below 26 indicates cognitive impairment.³²⁾ For SPPB, a score of 6 or lower indicates a high risk of falls.³³⁾

Data Analysis

For statistical analysis, the participants were divided into two groups for BADLs and two groups for IADLs. For BADLs, the decline group was defined as those with a BI score below 85, whereas that for IADLs was defined as an FAI score of less than 5, corresponding to the first quartile of the overall study subjects. The characteristics of the participants in the two groups were compared using the *t*-test, Mann-Whitney U test, or Chi-square test after evaluating normality and variance using the Shapiro-Wilk test. In ROC analysis, the area under the curve was calculated to evaluate the usefulness of determining the decline in performance in BADLs and IADLs for both CFFI and FES-I. In addition, ROC analysis was conducted to determine the optimal cutoff values. The logistic regression model was used to evaluate the influence of patients and CFFI on the scores for BADLs and IADLs, respectively. Covariables were adjusted in stages as follows: Model 1 used no adjustment (crude model); Model 2 was based on the crude model and used adjustments for age, sex, and SPPB (adjusted model). All statistical analysis was carried out using SPSS version 25 (IBM, Armonk, NY, USA). For all tests, $P \leq 0.05$ was considered significant; no correlation for multiple testing was performed.

RESULTS

Characteristics of Participants

There were 55 participants (each participant being a patient and primary caregiver pair). The characteristics of the patients are presented in **Table 1**. The mean age of the patients at the time of study entry was 83.1 ± 9.0 years, and 35 (63.6%) were female. Of the 55 primary caregivers, 28 (50.9%) were spouses and 27 (49.1%) were children. The 55 fracture sites were classified as follows: 26 involved a lower extremity (47.2%), 15 were in the spinal column (27.5%), 8 involved an upper extremity (14.5%), and 6 were classified as other (10.9%). A total of 49 (89.1%) patients showed cognitive decline (MoCA-J score <26),²⁵⁾ and 32 (58.2%) had a high risk of falling (SPPB score ≤ 6).²⁵⁾ Among the participants, 22 (40.0%) showed a decline in performance in BADLs and 14 (25.5%) exhibited a decline in IADL performance. In both groups with declines in performance in BADLs and IADLs, the SPPB scores were significantly lower and CFFI scores were significantly higher.

Results of ROC Analysis

The results of ROC analysis are shown in Fig. 1. The areas under the curve (AUCs) for BADLs and IADLs in CFFI were 0.73 ($P < 0.01$) and 0.77 ($P < 0.01$), respectively. In contrast, AUCs for BADLs and IADLs in FES-I were 0.53 ($P = 0.71$) and 0.61 ($P = 0.24$), respectively, indicating that CFFI has higher accuracy than FES-I as an indicator of reduced ADL performance. The cutoff points for CFFI to determine decline in performance in BADLs and IADLs for post-fracture patients were 42/43 (sensitivity: 77.3%, specificity: 60.6%) and 46/47 (sensitivity: 71.4%, specificity: 65.9%), respectively.

Results of Multivariate Analysis

The results of the logistic regression model are shown in **Table 2**. In the crude model, the odds ratio (95% confidence interval; P value) for CFFI was 0.91 (0.86–0.97; $P < 0.01$) for BADLs and 0.90 (0.83–0.97; $P < 0.01$) for IADLs. In the adjusted model (adjusted for age, sex, SPPB score ≤ 6), the odds ratio was 0.95 (0.88–1.02; $P = 0.16$) for BADLs and 0.92 (0.85–0.99; $P = 0.04$) for IADLs. When FES-I was used as an explanatory variable, neither BADLs nor IADLs was significant in the crude model.

DISCUSSION

This study investigated the relationship between caregivers' fear of post-fracture patients falling and the decline

in performance of home-visit rehabilitation patients who previously experienced fall-related fractures. The results indicated that caregivers' fear of patients falling did not act as an independent factor for patients' BADLs, but it was a significant variable for their IADLs, even after adjusting for age, sex, and physical function. To the best of our knowledge, this study is the first to demonstrate the potential association between caregivers' fear of post-fracture patient falling and a decline in performance in patients' daily activities.

The existence of a relationship between the performance in daily activities of care recipients and the psychological background of caregivers has been suggested in previous studies. Based on interviews with caregivers, Faes *et al.*³⁴⁾ reported that falls have significant physical and psychological impacts on both patients and family caregivers, leading to concerns about subsequent declines in patient activity. However, this study is the first to demonstrate the potential association between caregivers' fear for post-fracture patients and decreased performance of the patients. Our newly developed CFFI includes items related not only to a patient's physical function but also to the caregiver's environment and psychological background.²⁶⁾ In particular, IADLs have been reported to be influenced not only by physical function but also by lifestyle factors,³⁵⁾ and the influence of these factors may reflect the relationship with IADLs. In addition, previous studies reported that difficulty in performing IADLs increases the risk of falls more than difficulty in performing BADLs,³⁶⁾ and primary caregivers may not always recommend performing IADLs.

This study recruited patients receiving home-visit rehabilitation as the target participants. The activity levels of hospitalized patients are managed and adjusted by medical professionals, whereas the activity levels of patients living at home are entrusted to themselves or their families. Therefore, in the case of patients living at home, the psychological state of the primary caregiver is considered to have a significant impact on the patient's performance in daily activities. This study included patients with various fracture sites, including fractures of the lower extremities, spinal column, and upper extremities. Although the impact on physical function may vary depending on the location of the fracture, the study specifically focused on home-visit rehabilitation patients with reduced activity levels. Even after adjusting for physical function, the results still indicated a potential association between caregivers' fear of post-fracture patients' falling and a decline in patients' activities. Furthermore, the participants of the current study had relatively low levels of physical and cognitive functioning when compared with the total

Table 1. Characteristics of participants

	All subjects	BADLs			IADLs		
		Decline	No decline	P value	Decline	No decline	P value
Patients (n=55)							
Number	55 (100.0)	22 (40.0)	33 (60.0)		14 (25.4)	41 (74.5)	
Age (years)	83.1 ± 9.0	85.6 ± 6.4	81.4 ± 10.2	0.07	85.6 ± 6.4	81.4 ± 10.2	0.09
Sex (female)	35 (63.6)	19 (54.3)	16 (45.7)	<0.01	10 (28.6)	25 (71.4)	0.48
Relationship of caregiver				0.23			0.49
Spouse	28 (50.9)	9 (32.1)	19 (67.9)		6 (21.4)	22 (78.6)	
Child	27 (49.1)	13 (48.1)	14 (51.9)		8 (29.6)	19 (70.4)	
Required long-term care level							
Requiring support 2	9 (16.4)	0 (0.0)	9 (100.0)		1 (11.1)	8 (88.9)	
Long-term care 1	9 (16.4)	1 (11.1)	8 (88.9)		0 (0.0)	9 (100)	
Long-term care 2	12 (21.8)	3 (25.0)	9 (75.0)		1 (8.3)	11 (91.7)	
Long-term care 3	14 (25.5)	12 (85.7)	2 (14.3)		8 (57.1)	6 (42.9)	
Long-term care 4	9 (16.4)	4 (44.4)	5 (55.6)		2 (22.2)	7 (77.8)	
Long-term care 5	2 (3.6)	2 (100.0)	0 (0.0)		2 (100.0)	0 (0.0)	
Fracture site							
Upper extremity	8 (14.5)	3 (37.5)	5 (62.5)		0 (0)	8 (100.0)	
Lower extremity	26 (47.2)	8 (30.8)	18 (69.2)		6 (23.1)	20 (76.9)	
Spinal column	15 (27.5)	10 (66.7)	5 (33.3)		7 (46.7)	8 (53.3)	
Other	6 (10.9)	1 (16.7)	5 (83.3)		1 (16.7)	5 (83.3)	
Comorbidities							
Hypertension	41 (74.5)	16 (72.7)	25 (75.7)	0.80	11 (78.5)	30 (73.1)	0.69
Stroke	12 (21.8)	3 (25.0)	9 (75.0)	0.23	2 (16.7)	10 (83.3)	0.43
Neurodegenerative disease	9 (16.4)	4 (44.4)	5 (55.6)	0.77	3 (33.3)	6 (66.7)	0.55
Diabetes mellitus	10 (18.2)	2 (20.0)	8 (80.0)	0.15	2 (20.0)	8 (80.0)	0.66
Heart disease	16 (29.1)	6 (37.5)	10 (62.5)	0.81	4 (25.0)	12 (75.0)	0.96
Malignant disease	8 (14.5)	3 (37.5)	5 (62.5)	0.88	1 (12.5)	7 (87.5)	0.36
MoCA-J <26	49 (89.1)	21 (42.9)	28 (57.1)	0.22	1 (16.7)	5 (83.3)	0.60
SPPB ≤6	32 (58.2)	21 (65.6)	11 (34.4)	<0.01	1 (4.3)	22 (95.7)	<0.01
Caregivers (n=55)							
CFFI	44.5 ± 11.0	50.0 ± 10.2	40.8 ± 10.1	<0.01	52.4 ± 9.8	41.7 ± 10.1	<0.01
FES-I	40.4 ± 13.3	40.0 ± 13.6	40.6 ± 13.3	0.86	42.9 ± 11.9	39.5 ± 13.8	0.42

Data given as number (percentage) or mean ± standard deviation.

Requiring support 2, requires support with movements such as walking because of instability; Long-term care 1, requires assistance with daily activities such as bathing; Long-term care 2, requires support with movements including the act of standing up; Long-term care 3, cannot walk independently; Long-term care 4, requires assistance with all ADLs; Long-term care 5, completely dependent on care

population of community-dwelling elderly citizens, based on previous studies.^{32,37-39}) Regarding the ADL measures used in this study, BADLs were assessed using the Barthel Index, and a decline in performance was defined as a BI below 85.¹⁶⁾ In contrast, IADLs were assessed using FAI, and a decline in performance was defined as an FAI score lower than 5. A previous study suggested that poor physical function increases the physical burden on caregivers,⁴⁰⁾ and the research

findings may be specific to a subgroup of patients who have a poor level of activity even among those who live at home.

Although previous studies have reported a correlation between functional ability and cognitive function, this study found no clear correlation between a decline in performance (as defined in this study) and cognitive decline. All participants in this study received home-visit rehabilitation and showed lower physical and cognitive functions than simi-

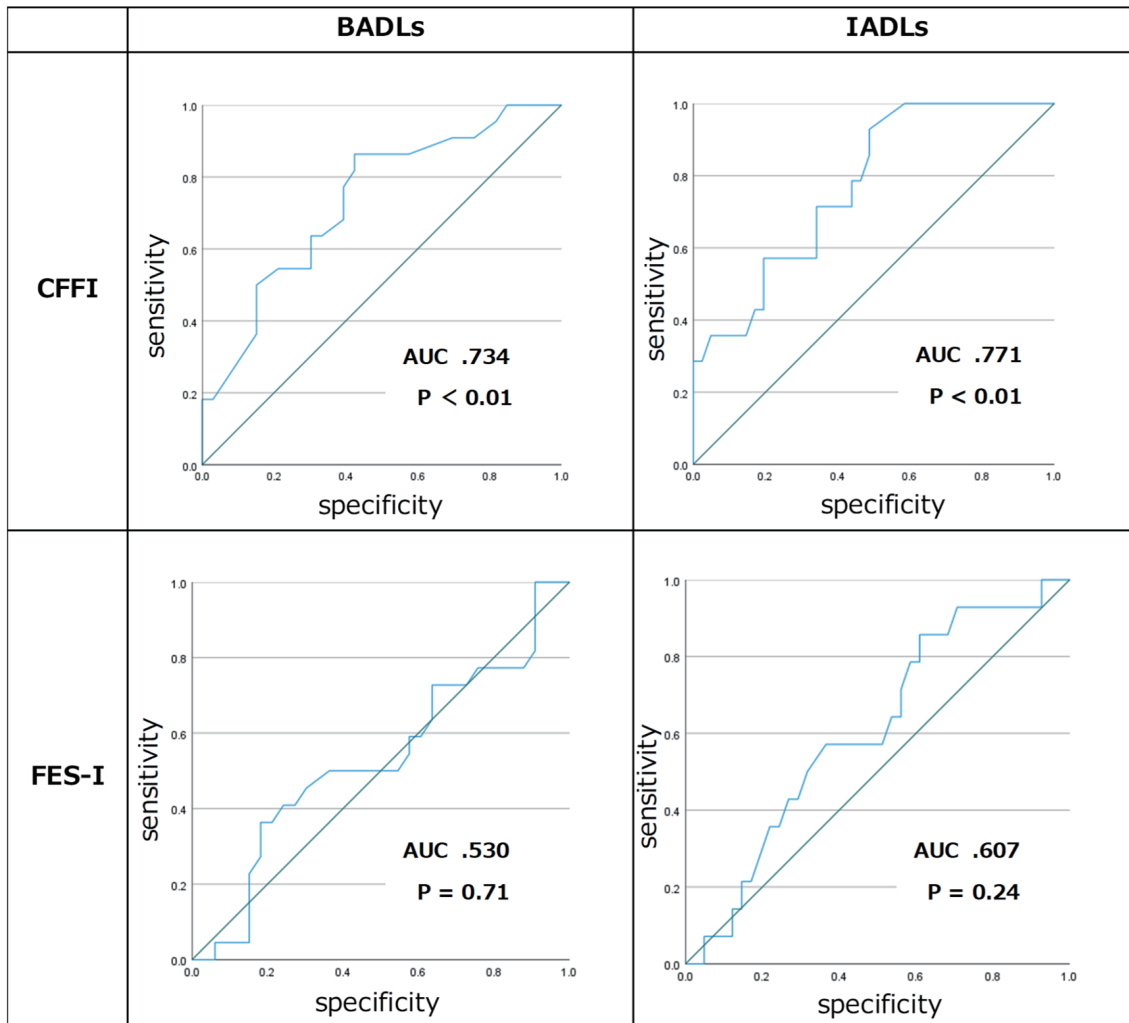


Fig. 1. ROC curves for discriminating impaired performance in BADLs and IADLs based on CFFI (upper) and FES-I (lower).

Table 2. Results of multivariate analysis

	Model 1 (crude model)			Model 2 (adjusted model)		
	OR	95% CI	P value	OR	95% CI	P value
BADLs						
CFFI	0.91	0.86–0.97	<0.01	0.95	0.88–1.02	0.16
IADLs						
CFFI	0.90	0.83–0.97	<0.01	0.92	0.85–0.99	<0.05

Model 2 adjusted for age, sex, SPPB score ≤ 6

larly aged community-dwelling citizens.^{32,37–39}) In fact, 89% of participants scored below 26 points on MoCA-J, which is an indicator of cognitive decline. Although this study did not identify a clear relationship between cognitive decline and declines in performance in BADLs and IADLs, the impact of cognitive decline on the functional ability of the elderly

is significant.^{41–43}) It is desirable to further investigate this issue by expanding the scope of the study to consider the influence of cognitive function.

This study has some limitations. First, this study focused on patients receiving home-visit rehabilitation as the target population. Although a wider range of participants was

considered when planning the study, it was anticipated that communication with primary caregivers, especially patients' families, would be difficult if inpatients were selected as participants under the circumstances of the COVID-19 pandemic. Furthermore, limited visitation by patients' family members could significantly alter the results. By narrowing the target group to patients receiving home-visit rehabilitation, it is possible that the participants in this study had lower functional levels than a general population with fall-related fractures. Second, the elapsed time from fracture to actual measurement was not standardized. In this study, the length of time from fracture to the resumption of ADLs varied among the participants because the start time of home-visit rehabilitation differed for each participant. As a result, the experience of patients and primary caregivers during home-visit rehabilitation may have affected the results. Third, this study did not consider the contents of the rehabilitation programs. Given that rehabilitation programs may differ in content, focus, and intensity, some types of rehabilitation may be more effective than others in reducing caregivers' fear of fall-related fracture.⁴⁴⁾ Therefore, future research should investigate the impact of different rehabilitation programs on caregivers' fear of fall-related fractures and should consider the content of rehabilitation as a potential moderator of such fears.

CONCLUSION

The results of this study suggest that caregivers' excessive fear of post-fracture patients falling is associated with a decline in the IADLs of these patients. These findings indicate that both patients and primary caregivers require guidance in supporting the daily activities of post-fracture patients. Future investigations using larger samples and longitudinal studies are needed to confirm the findings of this study.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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