

## ORIGINAL ARTICLE

## CUMULATIVE RISK AND ASSOCIATED FACTORS FOR FALL-RELATED FRACTURES IN STROKE SURVIVORS AFTER DISCHARGE FROM REHABILITATION WARDS: A RETROSPECTIVE STUDY WITH A 6-YEAR FOLLOW-UP

Masashi KUMAGAI, OT, PHD<sup>1,2</sup>, Yohei OTAKA, MD, PHD<sup>1,3</sup>, Taiki YOSHIDA, OT, MS<sup>1,4,5</sup>, Shin KITAMURA, OT, MS<sup>1,4,6</sup>, Kazuki USHIZAWA, OT, MS<sup>1,3</sup>, Naoki MORI, MD<sup>1,7</sup>, Daisuke MATSUURA, MD, PHD<sup>1</sup>, Kaoru HONAGA, MD, PHD<sup>1,8</sup>, Kunitsugu KONDO, MD, PHD<sup>1</sup> and Eiji SHIMIZU, MD, PHD<sup>2</sup>

From the <sup>1</sup>Department of Rehabilitation Medicine, Tokyo Bay Rehabilitation Hospital, Chiba, <sup>2</sup>Department of Cognitive Behavioral Physiology, Chiba University Graduate School of Medicine, Chiba, <sup>3</sup>Department of Rehabilitation Medicine I, School of Medicine, <sup>4</sup>Faculty of Rehabilitation, School of Health Sciences, Fujita Health University, Aichi, <sup>5</sup>Department of Health Sciences and Social Welfare, Waseda University Graduate School of Human Sciences, Saitama, <sup>6</sup>Department of Occupational Therapy, Tokyo Metropolitan University Graduate School of Human Health Sciences, Tokyo, <sup>7</sup>Department of Rehabilitation Medicine, Keio University School of Medicine, Tokyo and <sup>8</sup>Department of Rehabilitation Medicine, Juntendo University Graduate School of Medicine, Tokyo, Japan

**Objective:** To investigate the long-term cumulative risk and factors associated with fall-related fractures in stroke survivors discharged from convalescent rehabilitation wards.

**Design:** Retrospective cohort study.

**Participants:** A total of 786 stroke survivors discharged from a rehabilitation hospital.

**Methods:** Data regarding fall-related fractures post-hospital discharge were collected using self-reported questionnaires. The Kaplan–Meier method was used to calculate the cumulative incidence of fall-related fractures, and risk factors were analysed using Cox proportional hazard regression analysis.

**Results:** Of 1,861 consecutive stroke survivors who had been discharged from hospital, 786 (42.2%) provided information concerning fall-related fractures. Duration from time of discharge to time of collection of questionnaires ranged from 1 to 6 years (mean 38.0 months). The cumulative incidence of fall-related fractures at 1-, 2-, 3-, 4-, and 5-years post-discharge was 4.2%, 7.9%, 10.8%, 12.5% and 13.7%, respectively. Cox proportional hazard regression analysis indicated that female sex (hazard ratio (HR) 1.69) and moderate lower limb paresis (HR 3.08) were significant risk factors.

**Conclusion:** The cumulative risk of fall-related fractures in stroke survivors post-discharge from a rehabilitation hospital was notably high. Intensive preventive intervention should be considered for female stroke survivors with moderate lower limb paresis.

**Key words:** accidental fall; bone fracture; cerebrovascular disorder; rehabilitation; risk factor.

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Correspondence address: Yohei Otaka, Department of Rehabilitation Medicine I, School of Medicine, Fujita Health University 1-98 Dengakugakubo, Kutsukake, Toyoake, Aichi 470-1192, Japan. E-mail: otaka119@mac.com

### LAY ABSTRACT

This study aimed to investigate the risk of fall-related fractures and associated factors in stroke survivors who had been discharged from rehabilitation wards. A questionnaire was sent by post to 1,861 post-discharge stroke survivors to investigate their experiences of fall-related fractures, to which 786 stroke survivors responded. The incidence of fall-related fractures at 1, 2, 3, 4, and 5 years post-discharge was 4.2%, 7.9%, 10.8%, 12.5% and 13.7%, respectively. The presence of moderate lower limb paresis and female sex were associated with 3.08- and 1.69-times higher risk of developing a fall-related fracture, respectively. Intensive preventive intervention should be considered for female stroke survivors with moderate lower limb paresis following discharge from rehabilitation wards.

Stroke is a major cause of death and disability. Although global age-adjusted mortality rates for stroke have decreased, the absolute number of people who have strokes annually has been reported to be increasing, along with population growth and ageing (1). In Japan, the total number of stroke survivors receiving medical treatment was estimated to be 1,179,000 in 2014, and stroke was noted as the eighth most common disease (2). Furthermore, stroke was identified as the second most common cause of long-term care in 2016 (3). Therefore, appropriate management of stroke survivors is important from both medical and social perspectives.

Falling is one of the most frequently encountered complications among stroke survivors living in the community as well as in hospitals (4, 5). Stroke survivors frequently experience falls in the early period following hospital discharge, with up to 73% experiencing a fall within 6 months of discharge (6–10). Long-term stroke survivors in the community also experience falls more frequently than the general

population, albeit less frequently than in the early period after discharge (11–14). Falling can cause injuries, fractures, and psychological trauma, such as a fear of falling and depression, and these conditions further limit activities of daily living (5). The risk of fractures in stroke survivors is high (15–21), being 1.4–7 times higher than that of the general population (15–17, 19, 22), with most fractures reported to be due to falls (15, 17). Several studies have reported the incidence of fractures among stroke survivors (15–21); however, the incidence and factors influencing fall-related fractures post-discharge from rehabilitation wards, where individuals with impairments and disabilities are admitted following a stroke, have not been carefully investigated from a long-term perspective. Moreover, most previous studies investigating fractures in stroke survivors have included fractures that were not attributed to falls (15, 17), or the cause of the fractures was not specified (16, 18–22), with no studies having been limited to fall-related fractures. Furthermore, to our knowledge, no studies have investigated fall-related fractures in Asian countries, including Japan. Therefore, there is limited evidence concerning an appropriate fall-related fracture prevention strategy for stroke survivors post-discharge from rehabilitation wards in Japan.

This study aimed to investigate the long-term cumulative risk and factors associated with fall-related fractures in stroke survivors following discharge from rehabilitation wards.

## METHODS

### *Study setting and design*

The study was conducted at Tokyo Bay Rehabilitation Hospital, Chiba, Japan, which has specific convalescent rehabilitation wards (Kaifukuki Rehabilitation Wards; KRW). The KRW system was established in Japan in 2000 as part of a governmental insurance system for inpatient rehabilitation during the convalescent phase (23). Individuals with stroke are eligible for admission to the KRW within 2 months of stroke onset. Physical, occupational, and speech therapies for a maximum of 3 h per day, 7 times a week, can be provided as part of a comprehensive and intensive rehabilitation programme. The maximum length of stay is up to 150 days for individuals with stroke and 180 days for individuals with stroke who have severe cognitive disorders.

This retrospective cohort study comprised a cross-sectional questionnaire postal survey. The study protocol was approved by the local ethics committee (approval number 174-2). The postal questionnaire was

accompanied by an explanatory document describing the study and participant consent, which stated that a reply and completion of the questionnaire from stroke survivors or their families constituted informed consent to participate in the study.

### *Participants*

A total of 1,861 consecutive stroke survivors who had been discharged from the Tokyo Bay Rehabilitation Hospital between July 2011 and March 2017 were surveyed in April 2018. All stroke survivors who had been discharged from the hospital during the study period were included; therefore, no exclusion criteria were applied. The data from responders were included in the analyses after excluding participants with insufficient data for fall-related fractures.

### *Data collection*

In addition to demographic information, the questionnaire included information concerning fall-related fractures that had occurred following discharge from convalescent rehabilitation wards, including the number of events (none, once, twice), the date of the first fracture(s), and the location(s) of the first fracture(s) (i.e. hip, proximal humerus, wrist, lumbar vertebrae, pelvis, rib, other, or uncertain).

To assess independent factors associated with fall-related fractures, the following data were retrieved from medical records: sex, age, premorbid modified Rankin Scale (mRS) score (24), type of stroke (infarction, intracerebral haemorrhage, subarachnoid haemorrhage), history of previous stroke (no, yes), duration from onset to admission to the KRW, length of stay in the KRW, side of paresis (right, left, bilateral, no paresis), Stroke Impairment Assessment Set (SIAS) motor score (25) as the degree of paresis at discharge, Functional Independence Measure (FIM) score (26, 27), and destination (i.e. home, nursing home, or transferred to another hospital).

The mRS has been found to be a reliable measure of disability severity, involving a 6-point scale ranging from Grade 0 to 5 (0, no symptoms; 1, no significant disability despite symptoms; 2, slight disability; 3, moderate disability; 4, moderately severe disability, and; 5, severe disability) (24).

The SIAS has previously shown a high degree of inter-observer agreement (25). The SIAS includes 2 items related to the upper limb (knee-mouth and finger-function tests) and 3 items related to the lower limb (hip-flexion, knee-extension, and foot-pat tests), with each item scored from 0 (total paresis) to 5 (no paresis).

The FIM is a standardized and useful assessment tool for measuring independence in daily living, comprising motor and cognitive domains (26, 27). The motor

domain includes 13 items, with scores ranging from 13 to 91 points. The cognitive domain includes 5 items, with scores ranging from 5 to 35 points. Each item is scored on a scale of 1–7 points, resulting in a total of 18 items and total scores ranging from 18 to 126 points. A higher score indicates a greater degree of independence.

### Statistical analysis

Following a descriptive analysis of fall-related fractures, the Kaplan–Meier method was used to analyse the cumulative incidence rates of the first fall-related fractures post-discharge. The observation period was defined as the period from the time of hospital discharge to completion of the questionnaire. For those who had died, the observation period was from the time of hospital discharge to the time of death. To explore factors related to the risk of fall-related fractures, bivariate Cox proportional hazards regression analyses were performed for the variables described in the data collection subsection above. Subsequently, a multivariate Cox proportional hazards regression analysis of variables that showed significance in the bivariate analysis was performed. Multicollinearity between independent variables was assessed using Pearson's product moment correlation coefficients or Spearman's rank correlation coefficients, depending on the type of variable. We excluded 1 of the 2 variables that showed a high correlation ( $r \geq 0.8$ ). For motor paresis and activities of daily living, non-linear correlations might exist (20–22, 28, 29). Therefore, we categorized the SIAS and FIM motor scores in the regression analyses. For the SIAS scores, we calculated the total scores of the upper (ranging from 0 to 10 points) and lower limbs (ranging from 0 to 15 points) and we classified them into 5 severity categories, as follows: upper limb, 0–1, 2–3, 4–5, 6–7, 8–9, and 10 (no paresis) points; lower limb, 0–2, 3–5, 6–8, 9–11, 12–14, and 15 (no paresis) points. In individuals with bilateral paresis, the score on the weaker side was considered for this analysis. The total FIM motor score was classified into 7 categories, as follows: 13–25, 26–38, 39–51, 52–64, 65–77, 78–90, and 91 (totally independent) points. Independence of gait at discharge was defined as an FIM walking score  $\geq 6$  points.

Stata/MP 15.1 (StataCorp LLC, College Station, TX, USA) software was used for statistical analyses.  $p$ -values  $< 0.05$  were considered statistically significant.

## RESULTS

Of 1,861 individuals surveyed, there were 817 responses to the questionnaire, and data concerning

**Table I.** Participants' characteristics at admission/discharge to/from convalescent rehabilitation wards ( $n = 786$ )

Characteristics	
Age at admission, years, mean (SD)	68.4 (13.5)
Sex, female/male, $n$	307/479
Premorbid modified Rankin Scale, 0/1/2/3/4/5, $n^*$	429/75/51/37/16/0
History of stroke, no/yes, $n$	675/111
Type of stroke, infarction/intracerebral haemorrhage/subarachnoid haemorrhage, $n$	470/257/59
Duration from onset to admission, days, mean (SD)	35.1 (13.7)
Length of stay in convalescent rehabilitation ward, days, mean (SD)	92.3 (44.7)
Duration after discharge, months, mean (SD)	38.0 (19.0)
Side of paresis, right/left/both/none, $n^†$	310/286/41/89
Motor score on SIAS at discharge, median (IQR)	
Total upper limb function score <sup>‡</sup>	8 (4–10)
Total lower limb function score <sup>§</sup>	12 (8–15)
Independence of gait at discharge, independent/non-independent, $n^{**}$	475/282
FIM at discharge, median (IQR)	
Total score <sup>††</sup>	107 (80–119)
Total score of motor items <sup>‡‡</sup>	78 (60–87)
Total score of cognitive items <sup>§§</sup>	30 (22–34)
Discharge destination, home/nursing home/transferred to another hospital, $n$	698/73/15

Number of missing values: <sup>\*</sup> $n = 178$ , <sup>†</sup> $n = 60$ , <sup>‡</sup> $n = 77$ , <sup>§</sup> $n = 83$ , <sup>\*\*</sup> $n = 29$ , <sup>††</sup> $n = 30$ , <sup>‡‡</sup> $n = 29$ , <sup>§§</sup> $n = 30$ .

FIM: Functional Independence Measure; IQR: interquartile range;  $n$ : number; SIAS: Stroke Impairment Assessment Set; SD: standard deviation.

fall-related fractures were obtained from 786 (42.2%) individuals. Participant characteristics are listed in Table I. Duration since discharge from the KRW ranged from 1 to 6 years with a mean of 38.0 (standard deviation (SD), 19.0) months. The total observation period was 2,490 person-years. The survey revealed that 78 individuals had died since discharge; and 85, 153, 165, 89, 166, and 45 individuals had a mRS grade of 0, 1, 2, 3, 4, and 5, respectively.

Table II shows the details of fall-related fractures. In total, 99 fall-related fracture events occurred during the 2,490 person/year observation period. Among the 86 individuals who experienced fall-related fractures, 73 experienced 1 fracture event and 13 experienced 2 fracture events after discharge from the KRW. The incidence rate of fall-related fracture events was

**Table II.** Fall-related fractures in 786 participants

Items	
Respondent, participants/family/facility staff, $n$	410/375/1
Experience of fall-related fracture(s), none/once/twice, $n$	700/73/13
Time from discharge to the first fall-related fracture, months, mean (SD) <sup>*</sup>	18.4 (15.6)
Location of first fall-related fracture after discharge, $n^†$	
Hip (more-affected side/less-affected side)	35 (32/3)
Proximal humerus (more-affected side/less-affected side)	13 (13/0)
Wrist (more-affected side/less-affected side)	9 (3/6)
Lumbar vertebrae	8
Pelvis	5
Rib	4
Other	15
Uncertain	1

<sup>\*</sup>The date of the event was missing in 4 individuals.

<sup>†</sup>Four individuals had 2 fractures during the first fall-related fracture event. SD: standard deviation;  $n$ : number.

39.7 events/1,000 person-years. The first fall-related fracture occurred at a mean (SD) of 18.4 (15.6) months after discharge. Among 90 fracture locations, in which first fall-related fractures were noted, the hip was most frequently involved (38.9%,  $n = 35$ ), followed by the proximal humerus (14.4%,  $n = 13$ ) and the wrist (10.0%,  $n = 9$ ). Most hip and proximal humerus fractures occurred on the more-affected side than on the less-affected side (hip, 32: 3, respectively; proximal humerus, 13: 0, respectively). However, wrist fractures occurred more frequently on the less-affected side than on the more-affected side (wrist, 6: 3, respectively).

After excluding 4 individuals with insufficient information regarding the date of fall-related fractures (new total,  $n = 782$ ), the cumulative incidence rates (annual incidence rates) of fall-related fractures at 1, 2, 3, 4, and 5 years after discharge were 4.2 (4.2)%, 7.9 (3.7)%, 10.8 (2.9)%, 12.5 (1.7)%, and 13.7 (1.2)%, respectively. The Kaplan–Meier curve is shown in Fig. 1A.

The bivariate Cox proportional hazards regression analyses showed significant differences in 8 variab-

les; namely, sex, age, premorbid mRS grade, length of stay, upper limb function on the SIAS, lower limb function on the SIAS, independence of gait, and total score of cognitive items in the FIM (Table III). The total scores of upper and lower limb functions on the SIAS were significantly correlated with each other ( $r = 0.87$ ,  $p < 0.001$ ); therefore, only lower limb function on the SIAS, which was considered to be more strongly associated with fall-related fractures, was used as an independent variable in the multivariable Cox proportional hazards regression analysis.

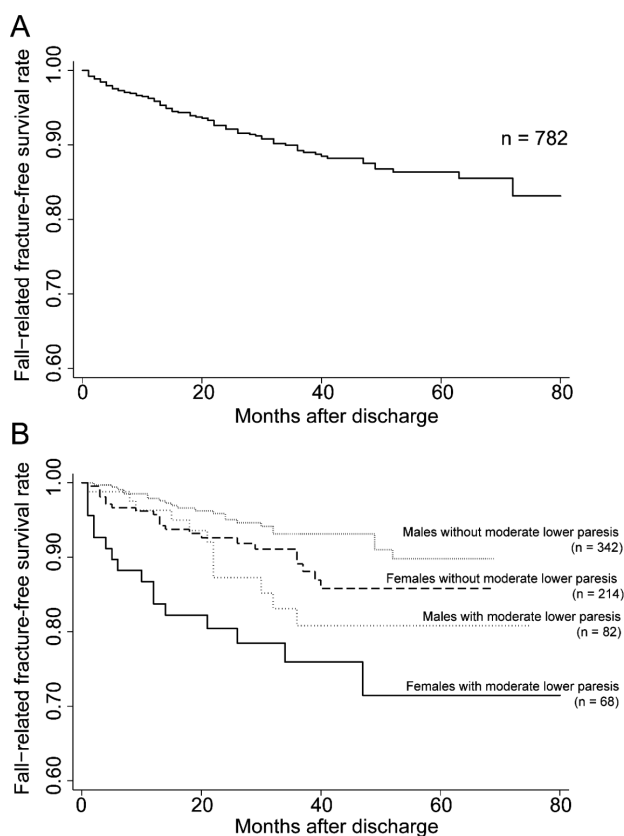
After excluding 201 participants with insufficient clinical variable data (including 25 participants with fall-related fractures), female sex (hazard ratio (HR), 1.69; 95% confidence interval (95% CI), 1.00–2.87;  $p = 0.049$ ), a total lower limb function score on the SIAS of 9–11 points (HR 3.08; 95% CI, 1.28–7.38;  $p = 0.012$ ), and a total lower limb function score on the SIAS of 6–8 points (HR 3.05; 95% CI, 1.18–7.87,  $p = 0.021$ ; Table IV) were found to be significant risk factors for fall-related fractures.

The Kaplan–Meier curves stratified according to sex and the presence of moderate paresis (total SIAS lower limb score ranging from 6 to 11 points) are shown in Fig. 1B. The cumulative incidence rates (annual incidence rates) of fall-related fractures in women with moderate lower limb paresis at 1, 2, 3, 4, and 5 years after discharge were 16.3 (16.3)%, 19.6 (3.3)%, 24.1 (4.5)%, 28.6 (4.5)%, and 28.6 (0.0)%, respectively.

## DISCUSSION

To our knowledge, this is the first study to elucidate the cumulative risk of fall-related fractures in stroke survivors after discharge from the KRW. Within this study cohort, hip fractures occurred most frequently, followed by proximal humerus fractures. Female sex and moderate paresis of the lower limbs were significantly associated with the risk of fall-related fractures.

In previous studies, most fractures (75–84%) among stroke survivors have been reported to be attributed to falls (15, 17). The incidence rate of fall-related fractures in the current study was 39.7 events/1,000-person-years, which was higher than the overall fracture risk of 22–37 events/1,000 person-years reported in previous studies concerning individuals with stroke, which included non-fall-related fractures (15, 17). This difference may have been observed because our study population was disabled to a greater degree, as all participants were eligible for inpatient rehabilitation. Compared with the general population, the incidence rate of fall-related fractures in a previous study was reported to be 17.9 events/1,000 person-years (30), which was significantly lower than the 39.7 events/1,000 person-years observed in the current



**Fig. 1.** Kaplan–Meier survival curve for freedom from fall-related fractures after discharge in participants with stroke. (A) Survival curve for all participants and (B) survival curves according to participant sex and severity of lower motor paresis. Y-axes show the percentage of participants who did not suffer fall-related fractures and x-axes show the time from discharge from convalescent rehabilitation wards. Moderate paresis, participants with Stroke Impairment Assessment Set (SIAS) lower limb scores ranging from 6 to 11 points.

**Table III.** Bivariate Cox proportional hazards regression analysis of variables related to fall-related fractures ( $n = 782$ )\*

Variable	Hazard ratio	95% confidence interval	p-value
Female sex	1.82	1.18–2.82	0.006
Age at admission, years	1.03	1.01–1.05	0.001
Premorbid modified Rankin Scale†			
Grade 0		Reference	
Grade 1	1.81	0.90–3.65	0.094
Grade 2	2.57	1.24–5.34	0.011
Grade 3	1.64	0.58–4.62	0.346
Grade 4	0.82	0.11–6.02	0.850
Grade 5	–	–	–
Type of stroke			
Infarction		Reference	
Intracerebral haemorrhage	1.13	0.72–1.78	0.582
Subarachnoid haemorrhage	0.47	0.14–1.51	0.208
Duration from onset to admission, days	0.99	0.97–1.01	0.609
Length of stay in convalescent rehabilitation ward, days	1.00	1.00–1.01	0.011
History of stroke	1.35	0.76–2.40	0.303
Side of paresis‡			
Right		Reference	
Left	1.58	0.97–2.59	0.065
Both	0.56	0.13–2.37	0.436
Total upper limb function score on the SIAS§			
Score 10		Reference	
Score 8–9	1.72	0.78–3.75	0.173
Score 6–7	4.12	1.81–9.41	0.001
Score 4–5	4.02	1.76–9.18	0.001
Score 2–3	1.97	0.77–4.99	0.153
Score 0–1	2.81	1.19–6.63	0.018
Total lower limb function score on the SIAS**			
Score 15		Reference	
Score 12–14	1.19	0.57–2.47	0.639
Score 9–11	3.43	1.63–7.21	0.001
Score 6–8	3.04	1.40–6.56	0.005
Score 3–5	2.09	0.86–5.05	0.100
Score 0–2	2.37	0.94–5.96	0.065
Independence of gait††			
Independent		Reference	
Non-independent	2.01	1.29–3.13	0.002
Total score of motor items in the FIM‡‡			
Score 91		Reference	
Score 78–90	1.10	0.33–3.63	0.864
Score 65–77	1.50	0.43–5.20	0.518
Score 52–64	2.33	0.65–8.26	0.190
Score 39–51	3.06	0.81–11.58	0.098
Score 26–38	2.98	0.80–11.04	0.101
Score 13–25	0.89	0.14–5.38	0.907
Total score of cognitive items in the FIM§§	0.97	0.94–0.99	0.029
Destination			
Home		Reference	
Nursing home	1.19	0.55–2.61	0.648
Different hospital	2.17	0.53–8.89	0.278

\*Of 786 participants, 4 had missing dates concerning their fall-related fractures.

Number of missing values: † $n = 178$ , ‡ $n = 149$ , § $n = 77$ , \*\* $n = 83$ , †† $n = 29$ , ††† $n = 29$ , §§ $n = 30$

FIM: Functional Independence Measure; SIAS: Stroke Impairment Assessment Set.

**Table IV.** Cox proportional hazards regression analysis of risk factors for fall-related fractures ( $n = 585$ )

Variable	Hazard ratio	95% confidence interval	p-value
Female sex	1.69	1.00–2.87	0.049
Age at admission, years	1.00	0.98–1.03	0.438
Premorbid modified Rankin Scale			
Grade 0		Reference	
Grade 1	1.22	0.58–2.59	0.588
Grade 2	1.61	0.70–3.72	0.258
Grade 3	1.20	0.40–3.59	0.734
Grade 4	0.39	0.04–3.07	0.373
Grade 5	–	–	–
Length of stay in convalescent rehabilitation ward, days	0.99	0.99–1.00	0.942
Total lower limb function score on the SIAS			
Score 15		Reference	
Score 12–14	1.13	0.50–2.55	0.757
Score 9–11	3.08	1.28–7.38	0.012
Score 6–8	3.05	1.18–7.87	0.021
Score 3–5	0.56	0.11–2.82	0.484
Score 0–2	1.51	0.44–5.18	0.512
Independence of gait			
Independent		Reference	
Non-independent	1.21	0.57–2.55	0.611
Total score of cognitive items in the FIM	0.99	0.95–1.04	0.992

FIM: Functional Independence Measure; SIAS: Stroke Impairment Assessment Set.

fracture rates 1.4–3.8 times higher than in the general population (15–17, 19, 22, 31, 32). Considering the incidence rates in current study and in previous studies, the risk of fall-related fractures observed in this study was similarly high.

The cumulative incidence rate of fall-related fractures for the 5 years following discharge was 13.7%, and the annual incidence rates of fall-related fractures was the highest (4.2%) in the initial period (within 1 year) after discharge. This finding seemed reasonable and was consistent with those of previous studies, in which the highest risk was observed immediately after the onset of stroke (16, 19). The incident risk has been reported to be 3–4% at 1 year (15, 18, 20) and 5–6% at 2 years (17, 21, 22) after the onset of stroke. Although the time from onset was longer in the present study because the starting point of the analysis was set as discharge from the KRW, these percentages are slightly lower than those reported in the current study. As noted earlier, this disparity may be attributed to differences in study population characteristics.

According to previous reports, fractures occur most frequently in the hip (15, 17, 20, 22) and on the more-affected side (14, 15, 17, 33) in stroke survivors. The current study showed similar findings, which might have been due to a tendency for participants to fall towards the weaker side (7, 34), difficulty in protecting paralysed limbs when falling, and reduced bone density on the affected side (35). Interestingly, an opposite tendency was found in wrist fractures, which were more frequently observed on the less-affected side.

study. The relative risk of fall-related fractures in the current study was 2.2 times higher than that in that previous study (30). These results are consistent with several previous studies that have reported incident

This finding supports the hypothesis that individuals with stroke are less likely to sustain a wrist fracture on the affected side because they are unlikely to break a fall through stretching out the affected arm (5).

Female sex and moderate lower limb paresis were found to be significantly associated with the risk of fall-related fractures. Regarding sex, it has previously been well established that fractures occur more frequently in female stroke survivors (15–17, 19, 20, 22). Within the general population, women have a greater risk of falling than men (36). In addition, a decrease in bone mineral density after stroke has been shown to be greater in women than in men (37). These 2 factors contribute to a higher incidence of fractures in female stroke survivors.

In this study, moderate lower limb paresis was significantly and strongly associated with the risk of fall-related injuries. Individuals with mild paresis may have less bone loss and a lower fall risk compared with individuals with moderate paresis. In contrast, individuals with severe paresis may have a lower fall risk because of reduced mobility. Thus, mobile individuals with limb weakness might have a greater risk of fall-related fractures. Although the effects of motor paresis severity have not been specifically assessed in previous studies, the current findings are supported by previous studies that have reported that moderate impairments (20, 22) and disabilities (21, 28, 29) are related to an increased risk of falling. A moderate initial stroke severity, defined using the Canadian Neurological Scale, has been associated with subsequent fracture risk in stroke survivors (22). Similarly, individuals with intermediate stroke severity, as defined by the National Institutes of Health Stroke Scale, had the highest risk of fractures (20). Furthermore, previous studies have reported that moderately severe disability in individuals with stroke is associated with a risk of falling (21, 28, 29). Therefore, our findings are consistent with previous reports of an inverted U-shaped relationship between impairment/disability and the risk of fractures.

The clinical significance of this study is that female sex and moderate lower limb paresis were identified as risk factors for fall-related fractures in stroke survivors after discharge from rehabilitation wards. Thus, it is necessary to undertake appropriate approaches to prevent fall-related fractures, especially in stroke patients with these risk factors. Currently, there is no clear evidence on the prevention of fall-related fractures in stroke patients, but exercise has been shown to be effective in preventing falls (38). Therefore, continuation of rehabilitation, including exercise, after discharge from rehabilitation wards for stroke patients should be considered a preventive measure against falls and fall-related fractures. Appropriate evaluation and treatment of osteoporosis in postmenopausal women

is also recommended, and should be considered a preventive intervention for fall-related fractures in women with stroke (39).

This study had several limitations. The retrospective design of the study and the relatively low response rate may have biased the results. It is possible that individuals who experienced fractures were more likely to respond; therefore, the incidence rates might have been overestimated. However, if individuals with stroke who experienced fall-related fractures had a poorer health status than individuals with stroke with a better health status, they might not have been able to reply, and the incidence might have been underestimated. Most respondents were individuals with stroke (or their families) whose cognitive function was not accurately assessed; thus, the reliability of their responses may be limited. This study was conducted at a single facility, and its findings may have limited generalizability to other institutions. The results of the Cox proportional hazards regression analysis showed a wide range of 95% CIs, which may be attributed to the variety of the characteristics among the participants or instability in the model. In future, data involving a large number of stroke survivors with specific characteristics should be collected and analysed. A prospective multicentre study with a larger sample size is required to confirm the current findings. Despite these limitations, we consider that this study provides valuable information concerning fall-related fractures in stroke survivors. In particular, we report for the first time the characteristics of individuals that have experienced a fall-related fracture after discharge from the KRW.

In conclusion, the incidence of fall-related fractures in stroke individuals after discharge from the KRW was 39.7 events/1,000 person-years, indicating a high risk. In particular, appropriate preventive interventions should be considered for female stroke survivors with moderate lower-limb paresis at discharge from rehabilitation wards.

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