Original Article Clinics in Orthopedic Surgery 2024;16:7-15 • https://doi.org/10.4055/cios23177

Prognostic Factors for Functional Recovery at 1-Year Following Fragility Hip Fractures

Nitchanant Kitcharanant, MD, Pichitchai Atthakomol, MD, Jiraporn Khorana, MD*,†, Phichayut Phinyo, MD†,‡,§, Aasis Unnanuntana, MD‖

Department of Orthopaedics, Faculty of Medicine, Chiang Mai University, Chiang Mai,
**Division of Pediatric Surgery, Department of Surgery, Faculty of Medicine, Chiang Mai University, Chiang Mai,*
†Center for Clinical Epidemiology and Clinical Statistics, Faculty of Medicine, Chiang Mai University, Chiang Mai,
‡Department of Family Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai,
§Musculoskeletal Science and Translational Research (MSTR), Faculty of Medicine, Chiang Mai University, Chiang Mai,
‖Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

Background: The main objective of treating fragility hip fractures is to maximize the patients' ability to return to their basic activities of daily living (ADL) levels. This study explored prognostic factors associated with the ability to recover pre-fracture ADL levels at 1 year after fragility hip fractures.

Methods: We retrospectively recruited patients admitted with fragility hip fractures between July 2016 and September 2018. Details of the following were extracted from electronic medical records: age, sex, body mass index; pre-fracture Charlson Comorbidity Index (CCI), Barthel index, and EuroQol-Visual Analog Scale (EQ-VAS) scores; pre-fracture ambulatory status; and fracture type and treatment. The primary endpoint was the ability to return to the pre-fracture ADL status at 1 year. Multivariable logistic regression analysis assessed the prognostic ability of predictors.

Results: Of 405 patients, 284 (70.1%) managed to return to their pre-fracture ADL status. Multivariable logistic regression analysis demonstrated that the predictor with the most apparent effect size was pre-fracture EQ-VAS scores ≥ 65 (multivariable odds ratio [mOR], 12.90; $p = 0.03$). Other influential predictors were CCI scores < 5 (mOR, 1.96; $p = 0.01$) and surgical treatment for the hip fracture.

Conclusions: Three prognostic factors can predict a hip fracture patient's ability to return to the pre-fracture ambulatory status at 1 year. They are the patient's CCI score, operative treatment for the hip fracture, and the pre-fracture EQ-VAS score. This information could be used to develop a clinical prediction model based on the prognostic factors.

Keywords: *Fragility hip fracture, Functional recovery, Prognostic factors*

The global population is rapidly aging, leading to an increase in the prevalence of osteoporosis and its severe consequences such as fragility hip fractures among geriatrics.[1] Fragility hip fractures are associated with higher mortality, morbidity, and disability rates,[2] significantly impacting patients' health and imposing an economic burden on society if left unaddressed.[3] Therefore, it is imperative to make serious efforts to improve the quality of care for patients with fragility fractures to prevent continued strain on the economy and society.

Fragility hip fractures are a severe condition with a 1-year mortality rate of approximately 15%–36%.[4] It can seriously impact physical activity, particularly the ability to

Received May 31, 2023; Revised July 30, 2023;
Accepted September 8, 2023
Correspondence to: Aasis Unnanuntana, MD
Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Rd, Bangkoknoi, 10700, Bangkok, Thailand
Tel: +66-83-687-1159
E-mail: uaasis@gmail.com
Nitchanant Kitcharanant and Pichitchai Atthakomol contributed equally to this study as co-first authors.

perform daily tasks and walking ability, which can affect the independence of older adults.[5] Previous studies have highlighted the impact of hip fractures, with only 60% of patients able to walk independently at 1 year[6] and only 49% at 2 years.[7] Nygard et al. reported that only 21% of patients could walk without a gait aid at the 1-year follow-up.[8] Only 23% to 50% of patients may return to their pre-fracture physical condition at the 1-year follow-up.[6] Age is a significant factor in the potential for functional recovery, with recovery rates progressively declining with age.[9]

Patients who were independent before their fracture have a higher chance (approximately 70%) of returning to their basic activities of daily living (ADL). However, those who were more dependent before their fracture are less likely to recover.[10] The loss of ADL function after a fragility hip fracture is associated with poor quality of life. The primary objective of treating fragility hip fractures is to help patients regain their independence and return to their pre-fracture level of functioning. To achieve this, interventions are required to aid in the recovery of ADL following a fragility hip fracture.

Most studies (73.5%) have investigated functional recovery at a short-term follow-up (range, 1–6 months), with few studies investigating the long-term impact of hip fractures on physical function beyond 6 months.[11] Furthermore, knowledge regarding the determinants of the long-term impact of hip fracture on ADL varies across studies. This study aimed to address this gap by exploring prognostic factors associated with the ability to return to the pre-fracture functional status at 1 year following a fragility hip fracture. By identifying these factors, we can improve our understanding of the long-term outcomes of hip fractures and develop targeted interventions to enhance functional recovery in patients.

METHODS

All procedures in studies involving human participants were performed in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The methodology used in this study was authorized by the Siriraj Institutional Review Board (No. 512/2022). The study was recorded in the Thai Clinical Trials Registry (TCTR20230330009) in Thailand. Given the retrospective design of this study, the need for informed consent was waived by the Scientific Ethics Committee of the Siriraj Institutional Review Board.

Design and Setting

We employed a retrospective observational cohort design to investigate prognostic factors associated with the ability to return to the pre-fracture functional status at 1 year following a fragility hip fracture. We recruited patients with fragility hip fractures admitted to a university-affiliated tertiary care center between July 2016 and September 2018.

Study Patients

To extract and analyze patient information from electronic medical records, we retrieved the International Classification of Diseases, 10th Revision (ICD-10) diagnosis codes S7200 (neck fracture of the femur) and S7210 (intertrochanteric fracture of the femur). Eligible patients were 50 years or older, had hip fractures resulting from low-energy trauma, and had a follow-up period of at least 1 year or until death. We included patients who were 50 years or older because fragility hip fractures can happen as early as age 50 years.[12] Additionally, patients older than 50 years with fragility fractures are at increased risk for recurrent fractures[13] and should be screened for osteoporosis, according to clinical practice guideline recommendations.[14] We excluded patients with multiple fractures or fractures resulting from malignancy, as determined by a pathological examination.

Treatment Protocol

A multidisciplinary care team consisting of orthopedic surgeons, geriatricians, physical therapists, nurses, and experts in metabolic bone disease provided the necessary services per our center's fragility hip fracture protocol.[15] Preoperative medical optimization was carried out following an evaluation by a geriatrician. If the patient's condition was suitable, an orthopedic surgeon performed the operative procedure. For patients with a low chance of survival, conservative treatment was chosen.

To prevent complications from extended immobility, a physical therapist initiated an individualized rehabilitation program for each patient as soon as possible. For both the patients who underwent surgery or received conservative treatment, the multidisciplinary care team approach continued to be crucial to the patient's recovery. All patients were urged to mobilize early. Physical therapists advised patients to use the walker to ambulate with weight-bearing as tolerated as soon as possible after surgery, as long as it was safe to do so. During their hospital stay, each patient typically had a daily 45-minute physical therapy session. Additionally, the physical therapists determined the risk of falling and created suitable home

exercise regimens. The entire procedure of providing care was adaptable and took each patient's condition into consideration. The advice for continued patient care was given to the caregivers as well. A metabolic bone disease specialist carefully reviewed the patient's clinical profile and laboratory results to ensure the appropriate initiation of anti-osteoporotic medication.[16] Before discharge from the hospital, patients and caregivers received education on osteoporosis and participated in a program to prevent falls.[17,18] Follow-up care was provided through phone contact with patients after discharge, at 3 months, and then annually.

Data Collection

We extracted the following data from electronic medical records: age, sex, body mass index, Charlson Comorbidity Index (CCI) score, pre-fracture ambulatory status (bedridden, dependent, or independent), pre-fracture Barthel index (BI) score, pre-fracture EuroQol-visual analog scale (EQ-VAS) score, type of fracture (femoral neck fracture or intertrochanteric fracture), and type of treatment (conservative, dynamic hip screw fixation, multiple screw fixation, cephalomedullary nailing, or arthroplasty). The BI is a validated instrument for assessing the functional performance of fundamental abilities for ADL and mobility in older patients.[19] It consists of ten items, each ranked on a scale and assigned a certain number of points. To evaluate patients' ability to perform ADLs at 1 year after their hip fracture, we conducted telephone interviews with the patients and determined their BI scores.

The total BI score ranges from 0 to 100, with a higher BI score indicating a greater chance of a patient being able to live independently at home. The scores are grouped into five categories (Table 1). Total dependence is signified by a score of less than 20, whereas high, moderate, and mild dependence are represented by scores of 20–39, 40–59, and 60–79, respectively. A score of 80–100 indicates independence.[19] The BI has been validated for evaluating a patient's functional return after hemiarthroplasty[20] and for telephone interviews.[21] If the BI scores at the pre-fracture state and at 1 year are in the same category, the patient has been able to return to their pre-fracture functional status.

The EQ-VAS is a self-evaluation questionnaire. It asks patients to rate their current state of health on a VAS ranging from 0 (worst potential health status) to 100 (best potential health status).[22] To maintain linearity assumptions, continuous data were classified according to previously published cutoff criteria. These criteria were age < 80 years,[23] CCI score < 5,[24] pre-fracture BI score ≥ 60,[19] and pre-fracture EQ-VAS score ≥ 65.[25]

Table 1. Categories of Barthel Index Score

Category	Barthel index score
Total dependence	< 20
High dependence	20–39
Moderate dependence	40–59
Mild dependence	60–79
Independence	80–100

Statistical Analysis

Data distribution was examined using histograms and the Shapiro-Wilk test. The mean and standard deviation are reported for normally distributed continuous data, whereas for non-normally distributed data, the median and interquartile range are presented. Fisher's exact test was used to compare categorical data, with results shown as counts and percentages.

Univariable logistic regression analysis was performed to evaluate the effect size of each parameter, and the resulting univariable odds ratio was reported. The primary endpoint was the ability to return to the pre-fracture ADL status at 1 year. To assess the predictors of this endpoint, multivariable logistic regression modelling was used, and the multivariable odds ratio (mOR) and 95% confidence intervals (CIs) were reported using a full model approach. All predictors were entered into the model. Statistical analysis was conducted using Stata 16 (StataCorp

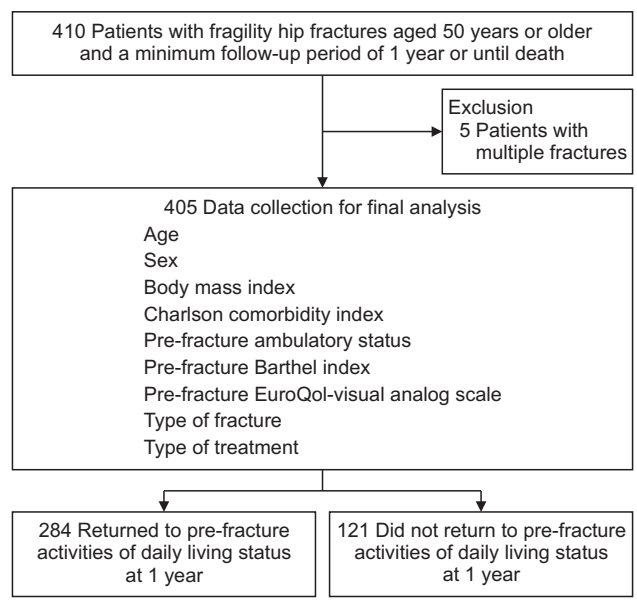

Fig. 1. Flowchart of the patient recruitment process.

LLC), and a two-tailed probability (p)-value of < 0.05 was considered statistically significant.

RESULTS

A total of 471 patients were admitted with fragility hip fractures from July 2016 to September 2018. During the 1-year follow-up, 61 patients died, and 5 patients were excluded due to multiple fractures. Therefore, the analysis included 405 patients aged 50 years or older with low-energy hip fractures and at least a 1-year follow-up period (Fig. 1).

Of the 405 patients, 284 (70.1%) managed to return to their pre-fracture ADL status (Table 2). Compared to patients who were unsuccessful in regaining their pre-fracture ADL status, those who achieved this outcome were significantly younger ($p < 0.001$), were more likely to have a CCI score < 5 ($p < 0.001$), were less likely to be bedridden during the pre-fracture period ($p < 0.001$), underwent conservative treatment options less often ($p < 0.001$), and had higher pre-fracture BI and EQ-VAS scores (p for each, < 0.001).

Univariable logistic regression analysis revealed that

Table 2. Comparison of the Demographic and Clinical Characteristics of All Patients and of Those in the Return and No Return to Pre-fracture Activities of Daily Living Status Groups

Patient characteristics	Returned to pre-fracture activities of daily living status (n = 284)	Did not return to pre-fracture activities of daily living status (n = 121)	*p*-value
Age (yr)	77 ± 10	81 ± 9	< 0.001
Age ≤ 80 yr	168 (59.2)	60 (49.6)	0.081
Female sex	209 (73.6)	93 (76.9)	0.534
BMI (kg/m^2)	22.58 ± 3.96	22.05 ± 3.76	0.210
< 18.5 kg/m^2	42 (14.8)	20 (16.5)	0.380
18.5 to < 25 kg/m^2	170 (59.9)	78 (64.5)	
≥ 25 kg/m^2	72 (25.3)	23 (19)	
Charlson comorbidity index score < 5	152 (53.5)	37 (30.6)	< 0.001
Pre-fracture ambulatory status			< 0.001
Bedridden	5 (1.8)	9 (7.4)	
Dependent	27 (9.5)	21 (17.4)	
Independent	252 (88.7)	91 (75.2)	
Femoral neck fracture	157 (55.3)	59 (48.8)	0.234
Treatment			< 0.001
Conservative treatment	3 (1.1)	15 (12.4)	
Dynamic hip screw	22 (7.7)	8 (6.6)	
Cephalomedullary nail	113 (39.8)	50 (41.3)	
Multiple screw fixation	14 (4.9)	3 (2.5)	
Arthroplasty	132 (46.5)	45 (37.2)	
Pre-fracture BI	97.20 ± 5.59	83.02 ± 17.11	< 0.001
Pre-fracture BI ≥ 60	283 (99.6)	108 (89.3)	< 0.001
Pre-fracture EQ-VAS	93.38 ± 7.68	81.61 ± 14.34	< 0.001
Pre-fracture EQ-VAS ≥ 65	283 (99.6)	106 (87.6)	< 0.001

Values are presented as mean ± standard deviation or number (%). A p-value < 0.05 indicates statistical significance.
BMI: body mass index, BI: Barthel index, EQ-VAS: EuroQol-visual analog scale.

Table 3. Logistic Regression Analysis of Prognostic Factors of Returning to Pre-fracture Activities of Daily Living Status at 1 year

Patient characteristics	Univariable			Multivariable		
	uOR	95% CI	*p*-value	mOR	95% CI	*p*-value
Age ≤ 80 yr	1.47	(0.96–2.26)	0.08	1.10	(0.66–1.86)	0.71
Female sex	0.84	(0.51–1.38)	0.49	0.83	(0.48–1.43)	0.50
BMI < 18.5 kg/m^2 (reference)						
BMI 18.5 to < 25 kg/m^2	1.04	(0.57–1.88)	0.90	0.94	(0.48–1.83)	0.86
BMI ≥ 25 kg/m^2	1.49	(0.73–3.03)	0.27	1.30	(0.58–2.89)	0.52
Charlson comorbidity index < 5	2.61	(1.66–4.11)	0.01	1.96	(1.15–3.33)	0.01
Pre-fracture ambulatory status						
Bedridden (reference)						
Dependent	2.31	(0.67–7.94)	0.18	1.08	(0.20–5.64)	0.93
Independent	4.98	(1.63–15.26)	0.01	1.58	(0.33–7.46)	0.57
Type of fracture						
Neck fracture	1.30	(0.85–1.99)	0.23	0.94	(0.35–2.55)	0.90
Treatment						
Conservative treatment (reference)						
Dynamic hip screw	13.75	(3.13–60.42)	0.01	7.98	(1.57–40.60)	0.01
Cephalomedullary nail	11.30	(3.13–40.78)	0.01	7.34	(1.69–31.83)	0.01
Multiple screw fixation	23.33	(4.02–135.39)	0.01	12.04	(1.71–84.83)	0.01
Arthroplasty	14.67	(4.06–53.01)	0.01	8.93	(2.10–38.01)	< 0.001
Pre-fracture BI ≥ 60	34.06	(4.40–263.55)	0.01	4.45	(0.33–59.92)	0.26
Pre-fracture EQ-VAS ≥ 65	40.05	(5.23–306.9)	0.01	12.90	(1.30–127.72)	0.03

A *p*-value < 0.05 indicates statistical significance.
uOR: univariable odds ratio, CI: confidence interval, mOR: multivariable odds ratio, BMI: body mass index, BI: Barthel index, EQ-VAS: EuroQol-visual analog scale.

CCI score, pre-fracture ambulatory status, surgical treatment options, pre-fracture BI scores ≥ 60, and pre-fracture EQ-VAS scores ≥ 65 were statistically significant predictors (Table 3). In the multivariable logistic regression analysis, three predictors were identified as independent predictors of returning to pre-fracture ADL status at 1 year. The predictor with the most apparent effect size was pre-fracture EQ-VAS scores ≥ 65 (mOR, 12.90; 95% CI, 1.3–127.72; $p = 0.03$). Other influential predictors were CCI scores < 5 (mOR, 1.96; 95% CI, 1.15–3.33; $p = 0.01$) and surgical treatment options. These operative procedures comprised dynamic hip screw (mOR, 7.98; 95% CI, 1.57–40.60; $p = 0.01$), cephalomedullary nail (mOR, 7.34; 95% CI, 1.69–31.83; $p = 0.01$), multiple screw fixation (mOR, 12.04; 95% CI, 1.71–84.83; $p = 0.01$), and arthroplasty (mOR, 8.93; 95% CI, 2.10–38.01; $p < 0.001$).

DISCUSSION

Fragility hip fractures significantly impact physical activity, particularly the ability to perform ADL, which in turn affects the independence of older adults.[5] Patients often do not regain their pre-fracture ambulatory status. After a fragility hip fracture, as few as 20% of patients recover to their pre-fracture ADL level within 6 months, and only 44.2% do so within a year of follow-up.[26] Achieving pre-fracture functional status is a major concern following a hip fracture, as fewer than half of the patients attain this goal.[27]

In our study, we observed that 70.1% of patients managed to return to their pre-fracture ADL status after a 1-year follow-up period. The reason for the discrepancy between our study's results and those of others remains unclear. Potential explanations include differences in the tools used to measure functional outcomes, variations in hip fracture treatment protocols, and distinct cultural settings among the studies. For example, in our country, cultural expectations regarding elderly care and social support exist, with most patients being sent home after hospital discharge. Upon returning home, dedicated family members or caregivers closely monitor and care for these patients, which may improve functional outcomes. This factor could contribute to the better results observed in our study population compared to those in other studies.

Several variables distinguished the two groups. Patients who could return to their pre-fracture ADL status were comparatively younger, had more instances of a CCI score below 5, were less likely to be bedridden during the pre-fracture period, and were more likely to undergo surgery to treat fragility hip fractures. Additionally, this group demonstrated better pre-fracture BI and pre-fracture EQ-VAS scores. These findings suggest that patients who returned to their pre-fracture ADL status had better overall health conditions at baseline. As a result, they had a greater likelihood of mobilizing and resuming daily activities following surgery.

According to Lim et al.,[11] predictive indicators for physical function after the discharge of hip fracture patients can be categorized into physical factors, factors related to the care process, psychosocial factors, demographics, injury-related factors, cognitive factors, and socio-economic factors. These indicators can be either non-modifiable or modifiable. Non-modifiable indicators assist clinicians in adjusting priorities and managing the essential, yet limited, resources needed for these high-risk patients. Such resources include intensive care units, operating theatres, and accessibility to intensive rehabilitation and fracture liaison services.[28] Conversely, modifiable predictive indicators enable physicians to target and provide early interventions to correct or optimize a patient's condition. Identifying these modifiable factors is crucial for developing intervention strategies tailored to specific patient problems, ultimately maximizing the functional recovery of a hip fracture patient.

We identified three predictors for returning to the pre-fracture ADL status at 1 year after fragility hip fracture: CCI scores < 5, surgical treatment options for hip fracture, and pre-fracture EQ-VAS scores ≥ 65. Multiple comorbidities have been suggested as a significant predictor of poor physical function in hip fracture patients.[29] As the number of comorbidities increases, cognitive impairment and length of stay are likely to rise in this group of older, fragile patients. This can cause both short- and long-term complications that may interfere with the ability of these patients to recover their physical function.[30] Therefore, patients with fewer comorbidities are more likely to return to their pre-fracture ADL status.

We also observed a difference in functional recovery between patients who underwent operative and conservative treatment. Ju et al. found that surgical treatment for intertrochanteric femoral fractures was associated with better functional recovery.[31] Furthermore, patients receiving surgical treatment for hip fractures tend to have improved postoperative functional outcomes and are more likely to return to their pre-fracture ambulatory status.[32] Since nonoperative treatment is linked to higher morbidity and mortality rates,[15] surgical treatment for hip fractures is currently being advocated to facilitate postoperative rehabilitation programs.

Pre-fracture BI scores have been found to correlate with both short- and long-term functional recovery. Uriz-Otano et al.[30] demonstrated that pre-fracture BI scores were associated with short-term recovery of ADL status at hospital discharge. Pre-fracture BI scores also predicted physical function at 1 year after hip fracture surgery in older adults.[26] Other studies have reported that poor ADL status at hospital discharge is associated with poor long-term physical function following surgery.[33]

However, in our study, a pre-fracture BI score of ≥ 60 could not predict functional recovery at 1 year after hip fracture. This is because the initial level of independence was not the sole primary factor in determining whether a patient could regain their physical function. In fact, the pre-fracture BI only assessed the ability to perform ADL at the onset of hip fracture and did not reflect a patient's overall health status or psychosocial condition. These additional factors are essential for identifying other health problems, such as pain, discomfort, and psychological distress, which may negatively affect functional recovery.[34]

In contrast, a pre-fracture EQ-VAS score of ≥ 65, which focuses on a patient's quality of life and overall health status, was significantly associated with the study outcomes. Previous research has shown that patients with a high pre-fracture quality of life generally ambulate well and have a high level of independence at baseline.[35] Moreover, baseline EQ-VAS scores have been associated with quality of life and death following a year of hip fracture.[36] A patient's quality of life might also be related to hip function.[31] Given these various findings, it is vital that

the overall health status of patients is assessed and that comprehensive evaluations are performed using multiple outcome measures. Doing so is particularly crucial in patients with a poor pre-fracture quality of life, as it could negatively impact their ability to recover long-term physical function.

Overall, the results of our study not only confirm earlier research's conclusions that pre-fracture functional status, comorbidity levels, and surgical interventions have a significant impact on recovery outcomes after fragility hip fractures, but they also emphasize the significance of pre-fracture EQ-VAS. A high pre-fracture EQ-VAS score (good health status) appears to be a significant predictive factor for fragility hip fractures. Our research showed the value of measuring pre-fracture self-rated health status and the correlation between a high pre-fracture overall health state and good functional recovery at 1 year following a fragility hip fracture. Given that other prognostic factor studies did not include a baseline EQ-VAS evaluation, this may be one of our study's strengths.[11,37] As a result, obtaining pre-fracture EQ-VAS is essential since it provides vital information on the patient's baseline overall health.

Our study has several limitations. First, we did not include certain variables, such as postoperative complications, in our analysis. These variables can affect perioperative outcomes and may help predict functional recovery following hip fractures. Second, individual institutions have unique treatment guidelines for patients with hip fractures, which may influence prognosis. Third, the present study has a retrospective cohort design, which may contribute to recall bias. However, we could retrieve all relevant data from our electronic medical records without missing values, and our use of validated questionnaires to assess patient outcomes helped minimize potential biases. Finally, differing definitions of return to pre-fracture functional levels and varying cutoff criteria for each variable could also alter the ability to predict outcomes.

Attaining pre-fracture functional status is the primary objective following a fragility hip fracture. We have identified three prognostic factors that can predict a hip fracture patient's ability to return to their pre-fracture ambulatory status at 1 year. These factors were the patient's CCI score, operative treatment for the hip fracture, and their pre-fracture EQ-VAS score. This information could be used to develop a clinical prediction model based on the prognostic factors.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge Ms. Wachirapan Narktang of the Department of Orthopaedic Surgery for her assistance with data collection and the nursing personnel at Siriraj Hospital (Mahidol University) for their cooperation throughout the study.

ORCID

Nitchanant Kitcharanant https://orcid.org/0000-0002-5660-2743
Pichitchai Atthakomol https://orcid.org/0000-0001-9737-4110
Jiraporn Khorana https://orcid.org/0000-0001-9023-0923
Phichayut Phinyo https://orcid.org/0000-0002-8543-6254
Aasis Unnanuntana https://orcid.org/0000-0002-5742-298X

REFERENCES

1. Wright NC, Looker AC, Saag KG, et al. The recent prevalence of osteoporosis and low bone mass in the United States based on bone mineral density at the femoral neck or lumbar spine. J Bone Miner Res. 2014;29(11):2520-6.
2. Marsh D, Akesson K, Beaton DE, et al. Coordinator-based systems for secondary prevention in fragility fracture patients. Osteoporos Int. 2011;22(7):2051-65.
3. Chandran M, Lau TC, Gagnon-Arpin I, et al. The health and economic burden of osteoporotic fractures in Singapore and the potential impact of increasing treatment rates through more pharmacological options. Arch Osteoporos. 2019;14(1):114.
4. Morri M, Ambrosi E, Chiari P, et al. One-year mortality after hip fracture surgery and prognostic factors: a prospective cohort study. Sci Rep. 2019;9(1):18718.
5. Chu LW, Chiu AY, Chi I. Impact of falls on the balance, gait, and activities of daily living functioning in community-dwelling Chinese older adults. J Gerontol A Biol Sci Med Sci. 2006;61(4):399-404.
6. Cooper C. The crippling consequences of fractures and their impact on quality of life. Am J Med. 1997;103(2):12S-19S.

7. Burns A, Younger J, Morris J, et al. Outcomes following hip fracture surgery: a 2-year prospective study. Am J Geriatr Psychiatry. 2014;22(8):838-44.

8. Nygard H, Matre K, Fevang JM. Evaluation of Timed Up and Go Test as a tool to measure postoperative function and prediction of one year walking ability for patients with hip fracture. Clin Rehabil. 2016;30(5):472-80.

9. Mayoral AP, Ibarz E, Gracia L, Mateo J, Herrera A. The use of Barthel index for the assessment of the functional recovery after osteoporotic hip fracture: one year follow-up. PLoS One. 2019;14(2):e0212000.

10. Beaupre LA, Cinats JG, Jones CA, et al. Does functional recovery in elderly hip fracture patients differ between patients admitted from long-term care and the community? J Gerontol A Biol Sci Med Sci. 2007;62(10):1127-33.

11. Lim KK, Matchar DB, Chong JL, Yeo W, Howe TS, Koh JS. Pre-discharge prognostic factors of physical function among older adults with hip fracture surgery: a systematic review. Osteoporos Int. 2019;30(5):929-38.

12. Colon-Emeric CS, Saag KG. Osteoporotic fractures in older adults. Best Pract Res Clin Rheumatol. 2006;20(4):695-706.

13. Mackey PA, Rosenthal LD, Mi L, Whitaker MD. Subsequent fracture prevention in patients 50 years and older with fragility fractures: a quality improvement initiative. J Healthc Qual. 2019;41(1):17-22.

14. Lems WF, Dreinhofer KE, Bischoff-Ferrari H, et al. EULAR/EFORT recommendations for management of patients older than 50 years with a fragility fracture and prevention of subsequent fractures. Ann Rheum Dis. 2017;76(5):802-10.

15. Kitcharanant N, Chotiyarnwong P, Tanphiriyakun T, et al. Development and internal validation of a machine-learning-developed model for predicting 1-year mortality after fragility hip fracture. BMC Geriatr. 2022;22(1):451.

16. Mahaisavariya C, Vanitcharoenkul E, Kitcharanant N, Chotiyarnwong P, Unnanuntana A. Exploring the osteoporosis treatment gap after fragility hip fracture at a Tertiary University Medical Center in Thailand. BMC Geriatr. 2023;23(1):70.

17. Sukchokpanich P, Anusitviwat C, Jarusriwanna A, Kitcharanant N, Unnanuntana A. Quality of life and depression status of caregivers of patients with femoral neck or intertrochanteric femoral fractures during the first year after fracture treatment. Orthop Surg. 2023;15(7):1854-61.

18. Kitcharanant N, Vanitcharoenkul E, Unnanuntana A. Validity and reliability of the self-rated fall risk questionnaire in older adults with osteoporosis. BMC Musculoskelet Disord. 2020;21(1):757.

19. Sinoff G, Ore L. The Barthel activities of daily living index: self-reporting versus actual performance in the old-old (> or = 75 years). J Am Geriatr Soc. 1997;45(7):832-6.

20. Unnanuntana A, Jarusriwanna A, Nepal S. Validity and responsiveness of Barthel index for measuring functional recovery after hemiarthroplasty for femoral neck fracture. Arch Orthop Trauma Surg. 2018;138(12):1671-7.

21. Della Pietra GL, Savio K, Oddone E, Reggiani M, Monaco F, Leone MA. Validity and reliability of the Barthel index administered by telephone. Stroke. 2011;42(7):2077-9.

22. Kim S, Won CW, Kim BS, et al. EuroQol Visual Analogue Scale (EQ-VAS) as a predicting tool for frailty in older Korean adults: the Korean Frailty an Aging Cohort Study (KFACS). J Nutr Health Aging. 2018;22(10):1275-80.

23. Welmer AK, Morck A, Dahlin-Ivanoff S. Physical activity in people age 80 years and older as a means of counteracting disability, balanced in relation to frailty. J Aging Phys Act. 2012;20(3):317-31.

24. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987;40(5):373-83.

25. Barton GR, Sach TH, Avery AJ, et al. A comparison of the performance of the EQ-5D and SF-6D for individuals aged >or= 45 years. Health Econ. 2008;17(7):815-32.

26. Chen YP, Kuo YJ, Liu CH, et al. Prognostic factors for 1-year functional outcome, quality of life, care demands, and mortality after surgery in Taiwanese geriatric patients with a hip fracture: a prospective cohort study. Ther Adv Musculoskelet Dis. 2021;13:1759720X211028360.

27. Scaf-Klomp W, van Sonderen E, Sanderman R, Ormel J, Kempen GI. Recovery of physical function after limb injuries in independent older people living at home. Age Ageing. 2001;30(3):213-9.

28. Chotiyarnwong P, Kitcharanant N, Vanitcharoenkul E, et al. Three-year outcomes of a fracture liaison service model at a university-based tertiary care hospital in Thailand. Arch Osteoporos. 2023;18(1):26.

29. Kim JL, Jung JS, Kim SJ. Prediction of ambulatory status after hip fracture surgery in patients over 60 years old. Ann Rehabil Med. 2016;40(4):666-74.

30. Uriz-Otano F, Uriz-Otano JI, Malafarina V. Factors associated with short-term functional recovery in elderly people with a hip fracture: influence of cognitive impairment. J Am Med Dir Assoc. 2015;16(3):215-20.

31. Ju JB, Zhang PX, Jiang BG. Risk factors for functional outcomes of the elderly with intertrochanteric fracture: a retrospective cohort study. Orthop Surg. 2019;11(4):643-52.

32. Malhotra R, Huq SS, Chong M, Murphy D, Daruwalla ZJ.

Outcomes in nonagenarians with hip fractures treated conservatively and surgically. Malays Orthop J. 2021;15(3):21-8.

33. Ishidou Y, Koriyama C, Kakoi H, et al. Predictive factors of mortality and deterioration in performance of activities of daily living after hip fracture surgery in Kagoshima, Japan. Geriatr Gerontol Int. 2017;17(3):391-401.
34. de Munter L, Polinder S, van de Ree CL, et al. Predicting health status in the first year after trauma. Br J Surg. 2019; 106(6):701-10.
35. Parsons NR, Costa ML, Achten J, Griffin XL. Baseline quality of life in people with hip fracture: results from the multicentre WHiTE cohort study. Bone Joint Res. 2020;9(8):468-76.
36. Amarilla-Donoso FJ, Roncero-Martin R, Lavado-Garcia JM, Toribio-Felipe R, Moran-Garcia JM, Lopez-Espuela F. Quality of life after hip fracture: a 12-month prospective study. PeerJ. 2020;8:e9215.
37. Sheehan KJ, Williamson L, Alexander J, et al. Prognostic factors of functional outcome after hip fracture surgery: a systematic review. Age Ageing. 2018;47(5):661-70.