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Risk Factors for Fragility Hip Fracture in the Older in Northern Thailand: A Community-Based Retrospective Cohort Study

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Purpose: This community-based retrospective cohort study aimed to identify risk factors for fragility hip fractures among older individuals in three districts of Nan Province, Thailand. The study addresses a knowledge gap regarding hip fracture risk factors specific to northern Thai communities.
Methods: Health data from the Nan Provincial Health Office database, covering the period January 1, 2019 to December 31, 2023, were analyzed for 36,521 older individuals aged ≥ 60 years. Participants had no prior history of hip fracture. Data on demographics, chronic diseases, use of walking aids, history of non-hip fragility fractures, and FRAX hip scores were collected. Multivariate Cox regression analysis was performed to identify significant risk factors for hip fractures.
Results: Key risk factors for hip fractures included female sex, age ≥ 70 years, body mass index (BMI) < 20 kg/m², use of walking aids, history of non-hip fragility fractures, hypertension, chronic obstructive pulmonary disease (COPD), chronic kidney disease, cerebrovascular accident, and Parkinson's disease. In males, significant risk factors included a BMI < 20 kg/m² and COPD, whereas in females, risk factors included hypertension, use of walking aids, and a FRAX hip score > 3.3%. Diabetes mellitus, dementia, heart disease, and lack of a caregiver were not found to be significant risk factors.
Conclusions: This study identified key risk factors for fragility hip fractures among community-dwelling older individuals in Northern Thailand, highlighting sex-specific risk profiles. The findings emphasize the need for targeted prevention strategies. Additionally, certain risk factors may be influenced by regional characteristics, geographical factors, and cultural aspects, limiting their generalizability.

Keywords: risk factor, fragility hip fracture, osteoporosis, community-based

The global population is aging, a trend particularly evident in developed countries. By 2050, an estimated 21% of the world's population will be 65 years or older [1]. Thailand is also experiencing rapid demographic aging, with projections indicating that over 14.2% of its population will be 65 or older by 2024 [2].

As life expectancy increases, age-related declines in physical function heighten the risk of falls, including hip fractures, which are becoming increasingly common [3]. Hip fractures not only pose serious health risks but also place a significant financial burden on healthcare systems. In Thailand, the average cost of hip fracture treatment is $5,013.25 (equivalent to 168,896.39 baht) [4]. In 2017, the incidence of hip fractures was 238.5 per

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100,000 population, resulting in annual treatment costs of approximately 1.76 billion baht [5]. Despite treatment, hip fractures are associated with severe complications and long-term consequences, underscoring the critical need for effective preventive strategies [6].

Several studies have examined risk factors for hip fractures in the older, identifying risk factors such as female sex, osteoporosis, hypertension, Parkinson's disease, diabetes, lung disease, and dementia [7,8]. However, findings across studies remain inconsistent. For instance, a study in Finland found that rheumatoid arthritis, diabetes, and a history of CVAs were not significant risk factors for hip fractures [9].

Cultural and lifestyle differences across populations, along with limited research on hip fracture risk factors in Thai communities, pose challenges for effective risk management. Additionally, tools such as dual-energy X-ray absorptiometry (DEXA) scans, commonly used to identify individuals at risk of fractures, may not be widely accessible in developing countries. As an alternative, the World Health Organization developed the Fracture Risk Assessment Tool (FRAX) to estimate the 10-year probability of hip fracture, using a threshold FRAX hip score of ≥ 3% [10]. However, Thai studies suggest sex-specific variations in the optimal FRAX cut-off values, with thresholds of 1.1% for men and 3.3% for women [11]. Given the multifactorial nature of hip fracture risk, a combination of risk factors and FRAX hip score should be used to improve screening accuracy for high-risk older individuals. This study aimed to identify important risk factors for hip fractures among high-risk older individuals in Northern Thailand to enhance early detection and prevention strategies in this population.

METERIALS AND METHODS

This retrospective cohort study included all older individuals aged ≥ 60 years residing in three districts of Nan Province (Mueang Nan, Phu Piang, Wiang Sa) who had no prior history of hip fracture. Older individuals with hip fractures because of severe trauma or pathological fracture were excluded. The study was conducted from January 1, 2019, to December 31, 2023. Health and mortality data were extracted from the Nan Provincial Health Office database. Collected variables included age, sex, weight, height, body mass index (BMI), caregiver presence, and history of non-hip fragility fractures. Data on chronic diseases such as type II diabetes mellitus (DM), hypertension (HT), chronic obstructive pulmonary disease (COPD), chronic kidney disease (CKD, defined as glomerular filtration rate < 60 ml/min/1.73 m^2), cerebrovascular accidents (CVAs), Alzheimer's disease, dementia, and Parkinson's disease were also collected. The Thai version of the FRAX hip score, excluding bone mineral density (BMD), was calculated using the online tool (https://frax.shef.ac.uk/FRAX/tool.aspx?lang=th).

For each participant, follow-up duration was calculated from the study's initiation to the occurrence of a hip fracture, death, or the study's end. Hip fractures were identified using International Classification of Diseases, 10th revision (ICD-10) codes S72.0, S72.1, and S72.2, retrieved from the Nan hospital database.

Clinical characteristics were summarized using descriptive statistics (frequencies, percentages, and means). Multivariate Cox regression analysis was employed to identify risk factors for hip fracture, reporting adjusted hazard ratios (HR) and 95% confidence intervals (CI). Statistical analyses were conducted using SPSS version 26 (IBM Corporation, Armonk, New York), with a statistical significance set at $p < 0.05$. This study was approved by the Research Ethics Committee of Nan Hospital (Nan Hos. REC No 014/2024).

RESULTS

This study included 36,521 older individuals residing in three districts of Nan Province (Mueang Nan, Phu Piang, Wiang Sa). Of these, 17,138 (46.9%) were male, and 19,383 (53.1%) were female. The mean age was 69.7 ± 7.8 years, ranging from 60 to 115 years, with the highest proportion of individuals in the 60-64 age group (31.6%). The average BMI was 22.4 ± 3.8 kg/m^2, with 9,526 individuals (26.1%) classified as underweight (BMI < 20 kg/m^2). Additionally, 5,926 (16.2%) had a FRAX hip score ≥ 3%.

Among the older study population, 4,034 individuals (11.0%) lived without caregivers or co-resided with other older individuals. A total of 2,768 (7.6%) required walking aids, and 610 (1.7%) had a history of non-hip fragility fractures. The prevalence of chronic diseases included DM in 4,178 individuals (11.4%), HT in 13,259 (36.3%), COPD in 797 (2.2%), CKD in 553 (1.5%), CVAs in 319 (0.9%), dementia in 188 (0.5%), and Parkinson's disease in 68 (0.2%) (Table 1).

During the follow-up period, 2,909 individuals died (Fig. 1). A total of 580 olderindividuals sustained hip fractures, comprising 171 males (1.0%) and 409 females (2.1%). The mean age at the time of fracture was 80.2 ± 8.3 years. The incidence rate of new hip fractures was 327.3 cases per 100,000 person-years, with a total follow-up duration of 9,214,421 weeks.

Multivariate Cox regression analysis identified several significant risk factors associated with hip fractures in the community (Table 2). Female sex was a significant predictor (adjusted HR = 1.64, $p < 0.001$), with the highest risk observed in individuals aged 90 years and older (adjusted HR = 15.05, $p < 0.001$). Other significant factors included BMI < 20 kg/m² (adjusted HR = 1.36, $p = 0.001$), use of a walking aid (adjusted HR = 1.83, $p < 0.001$), history of non-hip fragility fractures (adjusted HR = 1.65, $p = 0.004$), HT (adjusted HR = 1.27, $p = 0.006$), COPD (adjusted HR = 1.81, $p = 0.001$), CKD (adjusted HR = 1.69, $p = 0.020$), CVA (adjusted HR = 2.78, $p < 0.001$), and Parkinson's disease (adjusted HR = 4.16, $p = 0.002$).

Risk factor analysis was stratified by sex using FRAX score cut-off values of 1.1% for males and 3.3% for females. Among males, significant predictors of hip fracture included BMI < 20 kg/m² (adjusted HR = 1.64, $p = 0.004$), COPD (adjusted HR = 2.47, $p < 0.001$), CVAs (adjusted HR = 3.03, $p = 0.008$), Parkinson's disease (adjusted HR = 4.77, $p = 0.032$), and history of non-hip fragility fractures (adjusted HR = 3.64, $p = 0.002$) (Table 3).

For females, risk factors included FRAX hip score > 3.3% (adjusted HR = 1.88, $p = 0.045$), HT (adjusted HR = 1.27, $p = 0.023$), CVAs (adjusted HR = 2.91, $p < 0.001$), Parkinson's disease (adjusted HR = 3.87, $p = 0.020$), and use of a walking aid (adjusted HR = 2.03, $p < 0.001$), history of non-hip fragility fractures (adjusted HR = 1.52, $p = 0.031$) (Table 4).

In summary, specific risk factors for hip fractures in males included low BMI (< 20 kg/m²) and COPD, whereas in females, significant risk factors included HT, use of a walking aid, and FRAX hip score ≥ 3.3%.

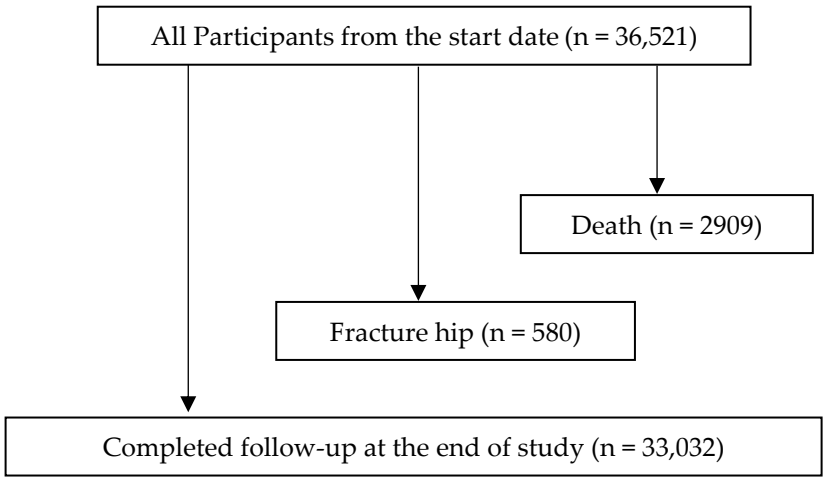

Fig. 1 Flow chart of the follow-up period.

Table 1 Clinical parameters. (N=36,521)

Characteristic	n (%)
Sex, female	19,383 (53.1)
Age group (year)	
60-64	11,529 (31.6)
65-69	9,817 (26.9)
70-74	6,298 (17.2)
75-79	4,036 (11.1)
80-84	2,647 (7.2)
85-89	1,539 (4.2)
90 up	655 (1.8)
BMI < 20 kg/m^2	9,526 (26.1)
FRAX hip score ≥ 3%	5,926 (16.2)
No Caregiver	4,034 (11.0)
DM	4,178 (11.4)
HT	13,259 (36.3)
COPD	797 (2.2)
Heart disease	1,088 (3.0)
CKD	553 (1.5)
CVA	319 (0.9)
Dementia	188 (0.5)
Parkinson disease	68 (0.2)
History of non-hip fragility fracture	610 (1.7)
Ambulate with gait aid	2,768 (7.6)

Table 2 Multivariate analyses of factors for predict fracture hip all sexes by FRAX hip score ≥ 3%.

Characteristic	Fracture hip	Adjusted HR	95% CI	*p*-value
Sex, female	409 (2.1)	1.64	1.285-2.028	<0.001
Age group (year)				
60-64	42 (0.4)	reference		
65-69	44 (0.4)	1.17	0.764-1.781	0.476
70-74	78 (1.2)	2.85	1.947-4.183	<0.001
75-79	106 (2.6)	5.40	3.628-8.027	<0.001
80-84	118 (4.5)	7.53	4.988-11.366	<0.001
85-89	132 (8.6)	13.87	9.018-21.341	<0.001
90 up	60 (9.2)	15.05	9.352-24.205	<0.001
BMI < 20 kg/m^2	267 (46.0)	1.36	1.124-1.634	0.001
FRAX hip score ≥3%	338 (58.3)	1.16	0.856-1.573	0.338
No Caregiver	50 (1.2)	1.20	0.897-1.607	0.219
DM	77 (1.8)	1.19	0.923-1.524	0.183
HT	310 (2.3)	1.27	1.073-1.512	0.006
COPD	35 (4.4)	1.81	1.280-2.561	0.001
Heart disease	31 (2.8)	1.21	0.841-1.742	0.305
CKD	21 (3.8)	1.69	1.085-2.659	0.020

Table 2 Multivariate analyses of factors for predict fracture hip all sexes by FRAX hip score ≥ 3%. (Cont.)

Characteristic	Fracture hip	Adjusted HR	95% CI	*p*-value
CVA	19 (6.0)	2.78	1.756-4.415	<0.001
Dementia	11 (1.9)	1.72	0.942-3.151	0.077
Parkinson's disease	5 (7.4)	4.16	1.718-10.078	0.002
History of non-hip fragility fracture	35 (5.7)	1.65	1.169-2.336	0.004
Ambulate with gait aid	192 (6.9)	1.83	1.507-2.222	<0.001

Table 3 Multivariate analyses of factors for predict fracture hip in male by FRAX hip score ≥ 1.1%.

Characteristic	Fracture hip n (%)	Adjusted HR	95% CI	*p*-value
Age group (year)				
60-64	8 (0.1)	reference		
65-69	11 (0.2)	1.49	0.599-3.708	0.391
70-74	29 (1.0)	4.31	1.801-10.313	0.001
75-79	27 (1.4)	4.04	1.346-12.102	0.013
80-84	41 (3.5)	9.03	3.071-26.550	<0.001
85-89	34 (5.5)	14.45	4.871-42.863	<0.001
90 up	21 (7.9)	20.32	6.556-62.980	<0.001
BMI < 20 kg/m^2	81 (1.9)	1.64	1.169-2.311	0.004
FRAX hip score ≥ 1.1%	138 (2.9)	2.00	0.915-4.369	0.082
No Caregiver	19 (0.9)	1.06	0.657-1.723	0.801
DM	23 (1.3)	1.50	0.943-2.388	0.087
HT	82 (1.5)	1.30	0.949-1.783	0.102
COPD	21 (4.5)	2.47	1.547-3.945	<0.001
Heart disease	9 (1.7)	1.08	0.548-2.143	0.816
CKD	11 (2.9)	1.88	0.995-3.560	0.052
CVA	6 (3.2)	3.03	1.329-6.901	0.008
Dementia	4 (4.7)	2.48	0.907-6.805	0.077
Parkinson's disease	2 (4.3)	4.77	1.14719.833	0.032
History of non-hip fragility fracture	6 (5.8)	3.64	1.604-8.261	0.002
Ambulate with gait aid	44 (4.4)	1.40	0.955-2.054	0.084

Table 4 Multivariate analyses of factors for predict fracture hip in female by FRAX hip score ≥ 3.3%.

Characteristic	Fracture hip n (%)	Adjusted HR	95% CI	*p*-value
Age group (year)				
60-64	34 (0.6)	reference		
65-69	33 (0.6)	1.09	0.677-1.767	0.713
70-74	49 (1.5)	2.22	1.428-3.457	<0.001
75-79	79 (3.7)	3.07	1.5356.144	0.002
80-84	77 (5.2)	3.34	1.6006.989	0.001
85-89	98 (10.7)	6.83	3.28014.240	<0.001
90 up	39 (10.0)	6.87	3.196-14.785	<0.001

Table 4 Multivariate analyses of factors for predict fracture hip in female by FRAX hip score ≥ 3.3%. (Cont.)

Characteristic	Fracture hip n (%)	Adjusted HR	95% CI	*p*-value
BMI < 20 kg/m²	186 (3.6)	1.22	0.984-1.500	0.070
FRAX hip score ≥ 3.3%	286 (6.3)	1.88	1.013-3.500	0.045
No Caregiver	31 (1.5)	1.27	0.876-1.830	0.209
DM	54 (2.3)	1.10	0.819-1.486	0.518
HT	228 (3.0)	1.27	1.033-1.554	0.023
COPD	14 (4.3)	1.25	0.7322.144	0.411
Heart disease	22 (3.9)	1.27	0.8241.954	0.280
CKD	10 (5.6)	1.51	0.7952.871	0.207
CVA	13 (9.7)	2.91	1.6665.088	<0.001
Dementia	7 (6.9)	1.51	0.7063.212	0.289
Parkinson's disease	3 (13.6)	3.87	1.238-12.111	0.020
History of non-hip fragility fracture	29 (5.7)	1.52	1.039-2.225	0.031
Ambulate with gait aid	148 (8.4)	2.03	1.613-2.541	<0.001

DISCUSSION

Hip fractures represent a significant public health concern, particularly among the older population. Identifying and understanding the associated risk factors are crucial for developing effective prevention and management strategies. This community-based retrospective cohort study highlights key risk factors contributing to hip fracture incidence.

Age and sex emerged as primary risk factors. Individuals ≥ 70 years faced a substantially higher risk, with the risk doubling approximately every five years. Notably, those aged ≥ 90 years exhibited a 15-fold higher risk compared to individuals aged 60-64 (95% CI: 9.352-24.205; p < 0.001). Aging negatively affects the musculoskeletal system, leading to both functional decline and muscle mass loss [12]. Additionally, disturbances in calcium homeostasis contribute to decreased bone mass [13], whereas age-related impairments in postural control, including visual and vestibular decline, further increase fall risk [14,15].

Females had a 1.6-fold higher risk of hip fracture than males (95% CI: 1.285-2.028; p < 0.001), which can be attributed to longer life expectancy (79.9 years for females vs. 71.9 years for males in Thailand in 2024) and estrogen loss on menopause[2,16].

Patients with HT exhibited a similar risk to that reported by Xu B et al. (adjusted rate ratio 1.34; 95% CI: 1.29–1.40; p < 0.001) [7]. Additionally, CKD was associated with a 2- to 4-fold increased risk of hip fracture compared to the general population of the same age group [17,18]. Both HT and CKD contribute to osteoporosis through abnormalities in the renin-angiotensin system, where increased angiotensin II levels stimulate osteoclast activity, inhibit osteoblasts, and disrupt calcium homeostasis [19-21].

Balance impairments and gait dysfunction in patients with stroke, Parkinson's disease, and those using gait aids were identified as significant risk factors for hip fracture [22-24]. Patients with Parkinson's disease had a 4.16-fold higher risk (95% CI: 1.718-10.078; p = 0.002), compared to the general population, exceeding the 2.6-fold increased risk reported in a Swiss study (95% CI: 1.4–4.6). This discrepancy may be attributed to limited access to disability support systems in developing countries.

Patients with COPD, a BMI < 20 kg/m², and a history of fragility fractures also exhibited significantly higher risks of hip fractures, with HRs of 1.81, 1.36, and 1.65, respectively. Graumam RQ et al. reported that up to 40% of COPD patients are underweight, exhibit osteoporosis, and have vitamin D deficiency [25]. Additionally, a meta-analysis by Morin SN et al. confirmed that

individuals with a history of fragility fractures have an increased risk of hip fractures (95% CI: 1.05–1.53; $p < 0.05$), which aligns with our findings [26]. This increased risk is primarily because of the early loss of trabecular bone in these individuals [27].

Interestingly, this study did not identify a significant association between DM or dementia and hip fracture risk. In contrast, Vilaca T et al. reported that type I DM increased hip fracture risk (relative risk = 4.93; 95% CI: 3.06-7.95), whereas type II DM was associated with a lower relative risk of 1.33 (95% CI: 1.19-1.49) [28]. The variability in findings across studies may stem from the heterogeneity of DM, including differences in disease type, duration, and severity. Additionally, strong social support systems in Thai families may provide protection against hip fractures in individuals with dementia, as suggested by Pothiban L. et al [29]. Furthermore, Yamaguchi T. et al found that individuals with DM had a higher femoral neck BMD than controls, which could explain the lack of association in this study [30].

When analyzed by sex, men with COPD (95% CI: 1.547-3.945; $p < 0.001$) and a BMI < 20 kg/m^2 (95% CI: 1.169-2.311; $p = 0.004$) exhibited a significantly increased risk of hip fracture. This disparity may be attributed to the high prevalence of COPD among Thai men, with smoking being the primary cause in 90% of cases [31].

Among females, significant factors included HT (95% CI: 1.033-1.554; $p = 0.023$) and the use of gait aids (95% CI: 1.613-2.541; $p < 0.001$). The protective role of estrogen against HT through its modulation of the renin-angiotensin system suggests that estrogen abnormalities in hypertensive women may contribute to increased fracture risk [32]. Furthermore, Patcharawan S. reported that gait aid users in Thailand are predominantly individuals older than 75 years and often have chronic conditions, aligning with the longer life expectancy of females, which may explain their increased fracture risk [33].

A study in Thailand determined that FRAX hip score cut-off values vary by sex (1.1% for men and 3.3% for women) [11]. Notably, when using a universal 3% cut-off for both sexes, the FRAX hip score was not identified as a significant risk factor predictor. However, when analyzed separately by sex using respective cut-offs, FRAX hip score was a significant predictor in females (95% CI: 1.013-3.500; $p = 0.045$) but not in males. These findings are consistent with Hamdy RC et al., who reported limited sensitivity and specificity of FRAX hip score in men [34].

This study benefits from a five-year longitudinal follow-up of a large community-based older population. However, limitations include its retrospective design and focus on the Northern Thai population, which may limit generalizability to other ethnic groups. Additionally, reliance on database-derived data precluded comprehensive assessment of disease severity.

Key risk factors for hip fracture were identified as age, sex, history of fragility fractures, and underlying conditions such as CVAs and Parkinson's disease. In men, COPD and a BMI < 20 kg/m^2 were significant risk factors for men, whereas in women, HT, FRAX hip score, and gait aid use were associated with increased risk. Future research should focus on developing screening and surveillance systems using these identified risk factors to proactively identify high-risk individuals and implement preventive measures to reduce hip fracture incidence.

CONCLUSIONS

Significant risk factors for hip fracture in community-dwelling older individuals in Northern Thailand include age ≥ 70 years, female sex, BMI < 20 kg/m^2, History of non-hip fragility fractures, use of a gait aid, HT, COPD, CKD, CVAs, and Parkinson's disease. Although DM, dementia, and lack of a caregiver were not identified as significant risk factors, implementing appropriate screening and surveillance systems and targeted fall prevention strategies for high-risk older individuals could potentially reduce hip fracture incidence in the older community.

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