นิพนธ์ต้นฉบับ

อัตราอุบัติการณ์และปัจจัยที่เกี่ยวข้องกับการเกิดกระดูกหักจากภาวะกระดูกพรุนของผู้ป่วยเบาหวานชนิดที่ 2 ; การศึกษาแบบย้อนหลังในโรงพยาบาลโคกสำโรง อำเภอโคกสำโรง จังหวัดลพบุรี ประเทศไทย

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บทคัดย่อ

ที่มาและความสำคัญ: การเกิดกระดูกหักจากภาวะกระดูกพรุนในผู้ป่วยเบาหวานชนิดที่ 2 (T2DM) เป็นปัญหาสำคัญที่ส่งผลต่อคุณภาพชีวิตและภาวะแทรกซ้อนทางสุขภาพในระยะยาว อย่างไรก็ตาม ข้อมูลเกี่ยวกับอุบัติการณ์และปัจจัยเสี่ยงในบริบทของประชากรไทยยังมีจำกัด การศึกษานี้มีวัตถุประสงค์เพื่อประเมินอัตราการเกิดกระดูกหักจากภาวะกระดูกพรุนและศึกษาปัจจัยที่เกี่ยวข้องในผู้ป่วยเบาหวานชนิดที่ 2 ที่โรงพยาบาลโคกสำโรง จังหวัดลพบุรี วิจัยนี้มีวัตถุประสงค์เพื่อศึกษาอัตราอุบัติการณ์การเกิดและปัจจัยที่เกี่ยวข้องต่อการเกิดกระดูกหักจากภาวะกระดูกพรุนของผู้ป่วยเบาหวานชนิดที่ 2 ที่โรงพยาบาลโคกสำโรง จังหวัดลพบุรี ประเทศไทย

วิธีการวิจัย: งานวิจัยนี้จะจัดทำในรูปแบบของ การศึกษาเชิงปริมาณ (Quantitative study) โดยทำการศึกษาผ่านการเก็บข้อมูลเวชระเบียนของผู้ป่วยนอก ผู้ป่วยใน และผู้ป่วยคลินิกโรคเรื้อรังของโรงพยาบาลโคกสำโรง ย้อนหลังตั้งแต่ปี พ.ศ. 2562 ถึง พ.ศ. 2567 เป็นการศึกษาแบบวิธี Retrospective cohort study เพื่อศึกษาปัจจัยที่เกี่ยวข้องกับกระดูกหักจากภาวะกระดูกพรุนของผู้ป่วยเบาหวานชนิดที่ 2 ในโรงพยาบาลโคกสำโรง อำเภอโคกสำโรง จังหวัดลพบุรี

ผลการวิจัย: การศึกษานี้พบว่าเพศหญิงมีความเสี่ยงต่อการเกิดกระดูกหักจากโรคกระดูกพรุนมากกว่าเพศชายในระดับไม่ปรับค่า (Crude IRR = 1.73; p = 0.009) แต่ไม่แตกต่างอย่างมีนัยสำคัญเมื่อปรับปัจจัยร่วม (Adjusted IRR = 0.85; p = 0.566) เช่นเดียวกับกลุ่ม BMI >30 ที่มีแนวโน้มลดความเสี่ยงแต่ไม่ถึงระดับนัยสำคัญทางสถิติ (Adjusted IRR = 0.87; p = 0.699) กลุ่ม BMI อื่น ๆ (Obesity 1, Overweight, Normal weight) ไม่มีความแตกต่างที่มีนัยสำคัญ (Adjusted IRR 1.16–1.47) กลุ่มอายุ ≥65 ปี สถานะการสูบบุหรี่ และการดื่มแอลกอฮอล์ไม่แสดงความสัมพันธ์กับความเสี่ยงของกระดูกหักเมื่อปรับค่าตัวแปรร่วม ขณะที่การควบคุมระดับน้ำตาลในเลือดแบบ FBG ที่ไม่ดีมีความสัมพันธ์กับความเสี่ยงที่เพิ่มขึ้นอย่างมีนัยสำคัญ (Adjusted IRR = 2.02; p < 0.002) แต่การควบคุม HbA1c ไม่สัมพันธ์กับความเสี่ยงดังกล่าว (p = 0.944) ปัจจัยที่มีความสัมพันธ์อย่างมีนัยสำคัญกับการเกิดกระดูกหัก ได้แก่ ประวัติการหกล้ม (Adjusted IRR = 2.15; p < 0.001), ความดันโลหิตสูง (Adjusted IRR = 2.72; p < 0.001), และไขมันในเลือดสูง (Adjusted IRR = 2.09; p = 0.004) ส่วนโรคไตเรื้อรังมีแนวโน้มเพิ่มความเสี่ยงแต่ไม่ถึงระดับนัยสำคัญ (p = 0.077)

สรุปผลการวิจัย: การควบคุมระดับน้ำตาลในเลือด ความดันโลหิต ไขมันในเลือด และการป้องกันการหกล้มเป็นปัจจัยสำคัญในการลดความเสี่ยงของการ กระดูกหักในผู้ป่วยเบาหวานชนิดที่ 2 มากกว่าปัจจัยด้านประชากรทั่วไป อายุ เพศ พฤติกรรมการสูบบุหรี่และการดื่มแอลกอฮอล์

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Original article

Incidence Rate and Associated Factors of Osteoporotic Fractures in Type 2 Diabetes Mellitus Patients; A Retrospective Cohort Study in Khoksamrong Hospital, Khoksamrong District, Lopburi Province, Thailand

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Abstract

Background: Osteoporotic fractures are a significant health concern in patients with type 2 diabetes mellitus (T2DM), who exhibit a higher fracture risk despite increased bone mineral density. This paradox is attributed to compromised bone quality and diabetes-related complications. In Thailand, especially in rural settings, data remain limited. This study aims to investigate the incidence and associated factors of osteoporotic fractures in T2DM patients at Khoksamrong Hospital, Lopburi Province, Thailand.

Methods: This research is a quantitative study conducted through a retrospective cohort study design, analyzing medical records of outpatients, inpatients, and chronic disease clinic patients at Khoksamrong Hospital from 2019 to 2024. The study aims to examine factors associated with osteoporotic fractures in T2DM patients at Khoksamrong Hospital, Khoksamrong District, Lopburi Province, Thailand.

Results: This study included 67.63% male patients. Over half were aged ≥65 years (53.73%). Obesity grades 1 and 2 accounted for 29.36% and 16% of participants, respectively. The most common fracture site was the hip (40.5%), followed by the radius (23.3%), ribs (20.7%), ankle (9.5%), vertebrae (3.4%), and humerus (2.6%). Females had a higher fracture rate (8.10%) than males (4.65%), and patients ≥65 years had a higher fracture rate (8.06%) than those <65 years (5.72%). Underweight patients showed the highest fracture rate (9.65%). Significant risk factors for osteoporotic fractures included uncontrolled fasting blood glucose (adjusted IRR = 2.02; 95% CI: 1.37–2.96; $p < 0.002$), fall history (IRR = 2.15; $p < 0.001$), hypertension (IRR = 2.72; $p < 0.001$), and dyslipidemia (IRR = 2.09; $p = 0.004$). CKD showed a non-significant trend (IRR = 1.86; $p = 0.077$). No significant associations were observed for sex, age, smoking, alcohol use, BMI, or HbA1c control after adjustment.

Conclusion: Osteoporotic fracture risk among T2DM patients is significantly associated with poor glycemic control, fall history, hypertension, and dyslipidemia. Early identification and management of these modifiable factors are crucial to reducing fracture risk in this population.

Keywords ● *Osteoporotic fracture* ● *Type 2 Diabetes* ● *association factors* ● *community setting* ● *Thailand*

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Introduction

Osteoporotic fractures are a major global health issue, especially among patients with type 2 diabetes mellitus (T2DM). Although T2DM is associated with higher bone mineral density (BMD), this does not reduce the increased fracture risk, as T2DM patients have a 1.3 to 2 times higher fracture risk compared to the general population. Studies have shown that various factors contribute to this increased risk, including deteriorating bone quality, altered bone structure, and complications from prolonged high blood glucose, such as neuropathy or retinopathy. Additionally, the accumulation of advanced glycation end products (AGEs) in collagen and reduced osteoblast function make bones more fragile in this patient group.

In Thailand, the incidence of T2DM is continuously rising due to an aging population and lifestyle changes, which increases the burden of osteoporosis and fracture-related issues. However, data on the incidence and factors associated with osteoporotic fractures among T2DM patients in rural areas, such as Khoksamrong District, remains insufficient. This lack of local data makes it difficult to develop effective,

Studying the epidemiology of osteoporotic fractures among T2DM patients, especially in under-researched rural areas, is crucial for improving patient health. Identifying modifiable factors, such as blood glucose control, diabetes duration, and associated complications, can help create effective prevention strategies to reduce the risk of osteoporotic fractures and improve patient quality of life. This study aims to address this gap by examining the incidence and factors associated with osteoporotic fractures among T2DM patients at Khoksamrong Hospital, Lopburi Province, Thailand.

Methods

Study design

This research is a quantitative study conducted through a retrospective cohort study design, analyzing medical records of outpatients, inpatients, and chronic disease clinic patients at Khok Samrong Hospital from 2019 to 2024. The study aims to examine factors associated with osteoporotic fractures in T2DM patients at Khoksamrong Hospital, Khoksamrong District, Lopburi Province, Thailand.

Participants and Setting

The inclusion criteria for research participants are as follows: Patients diagnosed with type 2 diabetes mellitus (T2DM), defined by an FBG ≥126 mg% or HbA1C >6.5, and receiving treatment at the general outpatient clinic, NCD outpatient clinic, or inpatient ward at Khoksamrong Hospital. The exclusion criteria include individuals who are foreign nationals, pregnant individuals, individuals with a history of non-traumatic fractures, individuals with a history of fractures due to accidents, and individuals with a history of medication that affects bone metabolism, such as bisphosphonates, raloxifene, strontium ranelate, and glucocorticoids.

Sample Size Estimation

From "Prevalence and Factors Affecting First and Recurrent Hip Fracture in the Elderly: A Retrospective Study from Inpatients at Thammasat University Hospital (2020)", the prevalence of fracture is 88%.

if Z = 1.96, P = 0.88, 1–P = 0.12, and e = 0.05

P is the population size

e is the margin of error

Give

P = 0.88 (The prevalence of fracture)

e = 5% of P; 0.05 x 0.88 = 0.044

95% CI; Z = 1.96

The sample size will be 89 people

Study Outcome Measurements

The incidence rate and associated factors of osteoporotic fractures in Type 2 Diabetes Mellitus Patients will be analyzed. Data will be collected from the Khoksamrong Hospital database covering the period from 2019 to 2024

Data Analysis

Data obtained from the Khoksamrong Hospital database will be organized into a table format suitable for statistical analysis using STATA 17.0. The data will be analyzed using descriptive statistics to summarize frequencies and calculate percentages of demographic characteristics of the sample group. This will include:

Descriptive statistics to present general population data, including counts and percentages.

Calculation of the incidence of osteoporotic fractures.

Poisson regression analysis will be employed, with a confidence level of 95% (95% confidence interval) and a p-value threshold of <0.05 for statistical significance.

Table 1. Demographic Data of T2DM Patients in This Study

Characteristics	No. of enrolled n (%)
Gender	
Male	1124 (67.63%)
Female	538 (32.37%)
Age (years)	
< 65	769 (46.27%)
≥ 65	893 (53.73%)

Table 1. Demographic Data of T2DM Patients in This Study (cont.)

Characteristics	No. of enrolled n (%)
BMI (kg/m²)	
< 18.5 (Underweight)	114 (6.86%)
18.5 - 22.9 (Normal)	489 (29.42%)
23.0 - 24.9 (Overweight)	305 (18.35%)
25.0 - 29.9 (Obesity 1)	488 (29.36%)
> 30.0 (Obesity 2)	266 (16.00%)
Site of Fracture	
Hip Fracture	47 (40.5%)
Ankle Fracture	11 (9.5%)
Radius Fracture	27 (23.3%)
Humerus Fracture	3 (2.6%)
Ribs Fracture	24 (20.7%)
Vertebrae Fracture	4 (3.4%)
Smoking Status	
Smoking	112 (6.98%)
Non-Smoking	1492 (93.02%)
Drinking Status	
Drinking	122 (7.61%)
Non-Drinking	1482 (92.39%)

Result

This study enrolled a higher percentage of male patients (67.63%) compared to females (32.37%). Nearly half of the patients are younger than 65 (46.27%), indicating a substantial proportion of the population that is not elderly. The remaining more than half of the patients are 65 years or older (53.73%), which reflects the typical age distribution in T2DM, as it is more common among older individuals. A small percentage of patients are underweight (6.86%), which could suggest other health conditions or a possible consequence of diabetes complications. A significant proportion had normal body weight (29.42%), suggesting that not all T2DM patients are overweight or obese. A smaller group is classified as overweight (18.35%). About 29.36% of the patients are classified as obese (grade 1), which is a significant percentage given the correlation between obesity and T2DM, and 16% of the patients are severely obese (grade 2), highlighting obesity as a major risk factor for T2DM. The most common site of fracture in this study was the hip (40.5%), which is common in elderly individuals, especially those with T2DM who may have weakened bones due to complications like osteopenia or osteoporosis. Ankle Fracture (9.5%), Radius Fracture (23.3%), Ribs Fracture (20.7%): These fractures are less common but still significant, as bone health is a major concern in patients with T2DM. Humerus Fracture (2.6%), Vertebrae Fracture (3.4%): These fractures are less frequent in the study population but still contribute to the overall fracture burden.

Among the study participants, females had a higher fracture rate (8.10%) compared to males (4.65%). This suggests that females with T2DM may have an increased risk of developing osteoporotic fractures compared to males. Older patients (≥65 years) showed a higher fracture rate (8.06%) compared to younger patients (<65 years), who had a fracture rate of 5.72%. This demonstrates that age is a significant factor in fracture risk for T2DM patients, with older individuals being at higher risk for osteoporotic fractures. Underweight patients (BMI <18.5) had the highest fracture rate (9.65%), followed by those with normal weight (18.5-22.9, 7.77%) and overweight (23.0-24.9, 8.52%) patients. Patients classified as Obesity 1 (25.0-29.9) and Obesity 2 (>30.0) had lower fracture rates (5.94% and 4.51%, respectively).

Crude IRR for females is 1.73 (95% CI: 0.57–0.89), suggesting that females may have a higher risk of osteoporotic fractures compared to males, with a statistically significant p-value of 0.009. However, after adjusting for other variables, the adjusted IRR of 0.85 (95% CI: 0.48–1.49) shows no significant difference between males and females (p = 0.566). Crude IRR for Obesity 2 (BMI >30) is 0.58 (95% CI: 0.30–1.10), suggesting lower fracture risk in this group. The adjusted IRR for Obesity 2 is 0.87 (95% CI: 0.44–1.74), showing no significant risk difference after adjusting for confounders (p = 0.699). For Obesity 1 (BMI 25-29.9), Overweight (BMI 23-24.9), and Normal weight (BMI 18.5-22.9), no significant difference was observed in fracture risk (adjusted IRRs ranging from 1.16 to 1.47). For patients ≥65 years, the crude IRR is 1.42 (95% CI: 0.96–2.12), indicating a trend toward higher fracture risk in older individuals. However, after adjustment, the adjusted IRR is 0.96 (95% CI: 0.63–1.47), suggesting that age does not significantly influence fracture risk once other factors are accounted for (p = 0.846). Smoking does not show a significant association with fractures, with both crude IRR (1.25) and adjusted IRR (1.10) being non-significant (p = 0.702 and p = 0.836, respectively). Alcohol consumption also does not have a significant association with fractures, with crude IRR of 1.54 (95% CI: 0.79–2.75) and adjusted IRR of 1.23 (95% CI: 0.56–2.70) showing no significance (p = 0.158 and p = 0.614, respectively). FBG control (well-controlled vs. poorly controlled) shows a statistically significant association with fracture risk, with an adjusted IRR of 2.02 (95% CI: 1.37–2.96) and a p-value of <0.002. HbA1c control shows no significant association, with adjusted IRR of 0.98 (95% CI: 0.50–1.89) and a p-value of 0.944. Fall history and Hypertension (HT) are both significantly associated with fracture risk, with adjusted IRRs of 2.15 (95% CI: 1.31–4.16) and 2.72 (95% CI: 1.54–4.78), respectively, both showing p-values <0.001. Dyslipidemia (DLP) and chronic kidney disease (CKD) also show significant associations with fracture risk, with adjusted IRR for DLP at 2.09 (95% CI: 1.26–3.48, p = 0.004) and CKD at 1.86 (95% CI: 0.93–3.69, p = 0.077) (non-significant after adjustment).

Discussion

For glycemic control and fracture risk, the finding that poor FBG control is associated with a significantly higher fracture risk is consistent with previous studies that suggest hyperglycemia can lead to bone fragility in T2DM patients. High glucose levels may impair bone mineralization and increase the risk of falls, thus contributing to fractures. However, HbA1c control was not significantly associated with fracture risk in this study, which may suggest that fasting glucose might be a more immediate and direct influence on bone health than longer-term glycemic control markers. This requires further investigation to clarify the relationship between glucose management and fracture prevention.

For T2DM complications as risk factors, the study revealed that hypertension, dyslipidemia, and a history of falls were strongly linked to fracture risk. Hypertension and dyslipidemia may contribute to vascular changes and bone metabolism disturbances, which could impair bone health and increase the likelihood of fractures. The high association between a history of falls and fracture risk further emphasizes the need for fall prevention strategies in T2DM patients. Falls can directly lead to fractures, especially in individuals with compromised bone health due to diabetes.

For BMI and bone health, the inverse relationship between BMI and fracture risk, particularly in obese individuals, is interesting. While obesity is generally associated with a higher risk of osteoporosis due to its impact on bone density and hormonal balance, the mechanical loading of bones in obese patients may provide some protective effect against fractures. However, obesity also brings a host of other health issues, such as inflammation and metabolic dysfunction, which require careful management. Further studies are needed to better understand the complex relationship between BMI and bone health, especially in T2DM patients.

Table 2. Relationship of Each Variable of T2DM with Osteoporotic Fracture

Characteristics	Fracture n (%)	Non fracture n (%)
Gender		
Male	25 (4.65%)	513 (95.35%)
Female	91 (8.10%)	1033 (91.90%)
Age (years)		
<65	44 (5.72%)	725 (94.28%)
≥65	72 (8.06%)	821 (91.94%)
BMI (kg/m²)		
< 18.5 (Underweight)	11 (9.65%)	103 (90.35%)
18.5 - 22.9 (Normal)	38 (7.77%)	451 (92.23%)
23.0 - 24.9 (Overweight)	26 (8.52%)	279 (91.48%)
25.0 - 29.9 (Obesity 1)	29 (5.94%)	459 (94.06%)
> 30.0 (Obesity 2)	12 (4.51%)	254 (95.49%)

Table 3. Associated Factors of Osteoporotic Fracture in T2DM Patients in This Study

Factor	Number of Patients	Person-Years ($x10^3$)	IR (Fractures/Person-Years $x10^3$)	Crude IRR (95% CI)	P-value	Adjusted IRR (95% CI)	P-value
Gender							
Male	25	2.5	0.98	0.57 (0.35-0.89)	0.009	0.85 (0.48-1.49)	0.566
Female	91	5.3	1.73	1			
Age Group (years)							
<65	44	4.2	17.22	1		1	
≥65	72	3.6	12.11	1.42 (0.96-2.12)	0.064	0.96 (0.63-1.47)	0.846
BMI Group							
< 18.5 (Underweight)	11	0.5	9.65	1.00 (0.30-1.10)	0.097	0.87 (0.44-1.74)	0.699
18.5 - 22.9 (Normal)	38	2.07	7.77	1.00 (0.47-1.24)	0.282	1.16 (0.68-1.98)	0.583
23.0 - 24.9 (Overweight)	26	1.65	8.52	1.11 (0.67-1.82)	0.687	1.47 (0.86-2.52)	0.155
25.0 - 29.9 (Obesity 1)	29	1.83	5.94	1		1.00 (0.64-2.46)	0.016
> 30.0 (Obesity 2)	12	1.26	4.51	1.26 (0.64-2.46)	0.507	2.53 (1.19-5.39)	0.016
Smoking status							
Smoking	10	0.5	1.89	1.25 (0.50-2.22)	0.702	1.10 (0.45-2.69)	0.836
Non-Smoking	106	7	1.5	1			
Alcohol status							
Drinking	13	0.5	2.27	1.54 (0.79-2.75)	0.158	1.23 (0.56-2.70)	0.614
Non-Drinking	103	6.9	1.48	1			
FBG Control							
Well	63	5.5	1.14	1		1	
Poor	53	2.3	2.31	2.02 (1.37-2.96)	<0.002	1.09 (0.72-1.65)	0.668
HbA1C Control							
Well	13	0.9	1.35	1		1	
Poor	103	5.8	1.5	1.11 (0.62-2.15)	0.754	0.98 (0.50-1.89)	0.944
T2DM Complications							
Fall							
Yes	76	2.22	0.34	1.04 (0.69-1.56)	0.867	2.15 (1.31-4.16)	<0.001
No	40	1.21	0.32	1			
HT (Hypertension)							
Yes	62	1.76	0.35	1.09 (0.74-1.60)	0.641	2.72 (1.54-4.78)	<0.001
No	54	1.67	0.32	1			
DLP (Dyslipidemia)							
Yes	41	1.24	0.32	0.96 (0.64-1.43)	0.853	2.09 (1.26-3.48)	0.004
No	75	2.19	0.34	1			
CKD (chronic kidney disease)							
Yes	19	0.57	0.32	0.97 (0.56-1.60)	0.931	1.86 (0.93-3.69)	0.077
No	97	2.86	0.33	1			

For sex, age, smoking, and alcohol, the lack of significant association between sex, age, smoking, and alcohol consumption in this study is notable, as these factors are often considered key contributors to osteoporosis and fracture risk in the general population. However, the influence of age and sex may be mitigated by other T2DM-specific factors, such as glycemic control and comorbidities. The finding that smoking and alcohol consumption did not significantly affect fracture risk in this cohort may be attributed to the fact that other factors (e.g., poor glycemic control or T2DM complications) overshadow the impact of these lifestyle factors. However, smoking and alcohol consumption remain important risk factors for general health and should still be addressed as part of an overall health management plan.

Limitations

Other factors that could be used to assess risk cannot be appropriately provided in this context, such as bone mineral density (BMD), vitamin D2 levels, and osteopenia diagnosis. Additionally, fasting blood glucose (FBG) and hemoglobin A1C (HbA1C) levels in patients with type 2 diabetes mellitus (T2DM) are not measured at every hospital visit.

Further research recommendations

The study results highlight multiple avenues for future research. For example, studies on the impact of bone density maintenance could analyze the effects of medication, or vitamin D and calcium supplementation, in T2DM patients to see if they can reduce fracture risk. Research could also explore the relationship between metabolic factors and fracture risk by studying the association between long-term controlled HbA1C levels and fracture risk, to assess whether strict glycemic control reduces the risk of osteoporosis, A prospective cohort study could be conducted for further data collection by following a population group over time, with continuous FBG and HbA1C measurements, to analyze long-term impacts. These studies would contribute to the development of more effective prevention and treatment methods to reduce fracture risk in T2DM patients and improve the health of this population in the long term.

Implication

Studies have found that sex, smoking, and fasting blood glucose (FBG) levels should be considered in type 2 diabetes mellitus (T2DM) patients due to their association with osteoporotic fractures, which may lead to burdens in daily life. T2DM patients with complications should pay special attention to cardiovascular complications and fracture risks, as indicated by various studies. This suggests that Khoksamrong Hospital should consider which type of blood glucose monitoring would be more beneficial for managing T2DM patients in terms of preventing long-term complications.

Conclusion

In conclusion, this study underscores the importance of tight glycemic control, managing T2DM complications, and monitoring BMI in reducing the risk of osteoporotic fractures in T2DM patients. Age, sex, smoking, and alcohol consumption did not significantly contribute to fracture risk once other variables were adjusted for, suggesting that other factors are more influential in this specific population. These findings provide valuable insights for clinicians aiming to reduce fracture risk and improve the overall management of T2DM patients.

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