



## Fracture Risk Assessment Tool (Frax Tool) Scores in Type 2 Diabetes Mellitus Patients in Haji Hospital Medan

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### ABSTRACT

**Background:** Diabetes mellitus (DM) is a metabolic disease characterized by chronic hyperglycemia resulting from defects in insulin secretion and/or insulin action. Bone fragility in T2DM, which mirrored bone mineral density and bone mass reduction. Classical diagnosis of osteoporosis in T2DM is performed by dual-energy X-ray absorptiometry (DXA) and the risk of fracture can be assessed using the FRAX tool (Fracture Risk Assessment Tool). The purpose of the study was to assess the risk of osteoporosis using FRAX tool calculation (without BMD) in T2DM patients at the endocrine metabolic clinic of Haji Hospital Medan. **Method:** Descriptive observational with a cross-sectional study approach using primary and secondary data from the medical records of the Endocrine and Metabolic Clinic of Haji Hospital Medan in September-October 2023. **Results:** Of the 80 respondents with a risk of major osteoporosis, there were 77 respondents (96.3%) with low risk, 3 respondents (3%) with moderate risk, and no respondents with high risk (0%). The FRAX score for the risk of hip fracture received a low risk of 72 respondents (90%). At the same time, the high-risk was 8 respondents (10%).

**Conclusion:** The majority of T2DM patients at Haji Hospital Medan are at low-risk for major osteoporosis and hip fracture.

**Keywords:** T2DM, Osteoporosis Risk, FRAX

### ABSTRAK

**Latar Belakang:** Diabetes mellitus adalah penyakit metabolik yang ditandai dengan hiperglikemia kronis akibat cacat sekresi insulin dan/atau aksi insulin. Kerapuhan tulang pada DM2 mencerminkan kepadatan mineral tulang dan pengurangan massa tulang. Diagnosis klasik osteoporosis pada DM2 dilakukan dengan dual-energy X-ray absorptiometry (DXA) dan risiko patah tulang dapat dinilai dengan menggunakan alat FRAX (Fracture Risk Assessment Tool). Tujuan dari penelitian ini adalah untuk menilai risiko osteoporosis dengan menggunakan perhitungan alat FRAX (tanpa BMD) pada pasien DM2 di klinik metabolik endokrin RS Haji Medan.

**Metode:** Observasional deskriptif dengan pendekatan studi cross-sectional menggunakan data primer dan sekunder dari rekam medis Klinik Endokrin dan Metabolik RSUD Haji Medan pada bulan September-Oktober 2023.

**Hasil:** Dari 80 responden dengan risiko osteoporosis mayor, terdapat 77 responden (96,3%) dengan risiko rendah, 3 responden (3%) dengan risiko sedang, dan tidak ada responden dengan risiko tinggi (0%). Skor FRAX untuk risiko patah tulang



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pinggul mempunyai risiko rendah 72 responden (90%). Pada saat yang sama, risiko tinggi adalah 8 responden (10%).

**Kesimpulan:** Mayoritas pasien DMT2 di Rumah Sakit Haji Medan berisiko rendah terkena osteoporosis berat pada tulang pinggul. Kata kunci: FRAX; DMT2

**Kata Kunci:** FRAX; DM Tipe 2

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## 1. Introduction

Chronic hyperglycemia, a metabolic condition caused by insufficient insulin secretion or activity, is the hallmark of diabetes mellitus (DM). Many organs, including the eyes (diabetic retinopathy and cataracts), kidneys (diabetic nephropathy), nerves (diabetic neuropathy), heart (diabetic cardiomyopathy), and blood arteries, are typically affected by chronic hyperglycemia (microangiopathy). Furthermore, DM is linked to various bone-related occurrences, such as falls in elderly individuals, as well as metabolic bone diseases, such as osteoporosis and small fractures. Type 1 diabetes (T1DM) and type 2 diabetes (T2DM) would manifest differently in terms of bone destruction, which could be caused by several cellular and molecular pathways [1].

Reduced bone strength and an increased risk of fracture are linked to both kinds of DM. Bone Mineral Density (BMD), a diagnostic test for osteoporosis, is higher in T2DM compared to (nondiabetic) controls but decreases in T1DM [2]. Complex pathways, including the insulin-insulin growth factor system, accumulation of advanced glycation end products in bone collagen, microangiopathy, and increased bone marrow fat content, mediate the relationship between diabetes and bone. Bone fragility in T2DM, which is not reflected by bone mineral density and bone mass reduction, is dependent on decreased bone quality. Classical diagnosis of osteoporosis in T2DM is done by dual-energy X-ray absorptiometry (DXA), and the risk of fracture can be seen using the FRAX Tool (Fracture Risk Assessment Tool) [3].

In Chinese individuals with diabetes, osteoporosis is a common comorbidity, according to systematic research and meta-analyses. It was discovered that the frequency of DM patients with osteoporosis was 27.67 percent worldwide [4]. Theoretically, because of their hyperglycemia, diabetic people have decreased bone mass readings. Problems arise from hyperglycemia in long-term DM. Bone mass is also influenced by several risk variables, including age, gender, and hormones. There is an imbalance between bone turnover and resorption as people age [5]. Duration of T2DM (e.g. >10 years), insulin therapy, and chronic complications of T2DM are associated with fragility fractures independent of Bone Mineral Density (BMD) [6]. The purpose of the study was to assess the risk of osteoporosis using FRAX tool calculation (without BMD) in DMT2 patients at the endocrine metabolic clinic of Haji Hospital Medan.

## 2. Method

This research was a descriptive study with a cross-sectional research design of people who are patients with T2DM who underwent treatment at the Endocrine and Metabolic Clinic of Haji Hospital Medan. This research was run from September to October 2023. The study was conducted after obtaining ethical clearance approval from the USU ethics committee.

The sample is an affordable population that meets the inclusion criteria: patients diagnosed with T2DM in the range of 40-90 years who want to participate in the study after being informed consent by the researcher. Patients with other metabolic endocrine diseases and incomplete medical record data were excluded from this study. The data collection method uses primary and secondary data, which is data obtained directly from the sample by interviewing the patients about the FRAX Tool questionnaire. Information about medication and comorbidities is obtained through the patient's medical record data.

### 2.1. Statistical Analysis

All responses from respondents will be entered and calculated with the FRAX Tool, which can be accessed for free on the Internet. All data were processed and analyzed statistically using SPSS ver.25. Categorical variables are presented with frequency (n) and percentage (%).

## 3. Result

The results of this study obtained basic patient data consisting of gender, age, BMI, duration of DM, blood glucose when the patient came for treatment, medications, and comorbidities of T2DM patients at Haji Hospital Medan. The results of this study also obtained the value of the FRAX tool to see the risk of major osteoporosis and hip fracture in the next 10 years in T2DM patients. The total data taken from this study was 87 respondents,

with 7 respondents dropping out due to incomplete data. The total respondents in this study were 80 patients who met the inclusion and exclusion criteria.

Based on table 1 presents basic data of T2DM patients, including gender, age, BMI, duration of DM, KGD when the patient comes for treatment, medications, and comorbidities. Based on age, women make up the majority of T2DM patients, namely 51 respondents (63.7%). According to age, the largest age category was 51-60 years old, with as many as 32 respondents (40%). Based on body mass index (BMI), obese I was the most common BMI category in patients with T2DM, total 25 respondents (31.3%). Based on the duration of a patient suffering from T2DM, that is, from the initial diagnosis to the present, the most with a duration of >5 years, namely 56 respondents (70%). According to blood glucose at the time, which is the examination when the patient comes for control, most of the patients have uncontrolled blood glucose, which is >200 g/dL, with as many as 42 respondents (52.5%). Based on medications, most were taking monotherapy, with as many as 44 respondents (55%). Based on comorbidities, macroangiopathy, such as hypertension, was the most common comorbidity, with 53 respondents (66.3%).

Table 1. Subject Data Distribution

Characteristics	Frequency (%)
Gender	
Man	29 (36.3%)
Woman	51 (63.7%)
Age (year)	
40 – 50	13 (16.3%)
51 – 60	32 (40%)
61 – 70	28 (35%)
71 – 80	6 (7.5%)
> 80	1 (1.3%)
BMI (kg/m <sup>2</sup> )	
Underweight	1 (1.3%)
Normal	20 (25%)
Overweight	23 (28.7%)
Obese I	25 (31.3%)
Obese II	11 (13.8%)
Duration of DM (year)	
<5	24 (30%)
≥5	56 (70%)
Blood glucose (mg/dL)	
≤200	28 (47.5%)
>200	42 (52.5%)
Medication	
Monotherapy	43 (53.8%)
Combination	
- 2 drugs	
a. OAD-OAD	15 (18.8%)
b. OAD-Insulin	13 (16.3%)
c. Insulin-Insulin	1 (1.3%)
- 3 drugs	
a. OAD-OAD-OAD	6 (7.5%)
b. OAD-OAD-Insulin	2 (2.5%)
Comorbidities	
Macroangiopathy	53 (66.3%)
Microangiopathy	1 (1.3%)
Without comorbidities	26 (32.5%)

OAD: oral antidiabetic drug

Based on table 2 shows that out of a total of 80 respondents, the majority all respondents with FRAX tool values <10%, which categorized with low-risk of major osteoporosis in the next 10 years, 77 respondents with FRAX tool results <3%, is a low-risk of hip fracture in the next 10 years, 72 respondents

Table 2. FRAX Tool Score

FRAX Tool Score		Frequency (%)
Osteoporosis Mayor		
Low-risk	(<10%)	77 (96.3%)
Moderate-risk	(10%-20%)	3 (3.8%)
High-risk	(>20%)	0 (0%)
Hip Fractures		
Low-risk	(≤3%)	72 (90.0%)
High-risk.	(>3%)	8 (10.0%)

Based on table 3 shows the distribution of major osteoporosis risk based on the basic data of the research subjects. Based on gender, women constitute the majority of low-risk and moderate-risk for major osteoporosis, namely 48 respondents for low-risk and 3 respondents for moderate-risk. Based on age, the age group 51-60 years was the largest group with a low risk of major osteoporosis, with as many as 32 respondents, while the moderate risk was in the age category 61-70 years, 71-80 years, and >80 years with 1 respondent each. Based on the BMI category, the obesity I category is the largest category for low-risk major osteoporosis, namely 25 respondents. While moderate-risk, it is in the normal category with 2 respondents. For the category of the length of time the subject suffered from DM, the majority of respondents with low and moderate were with a length of DM > 5 years, as many as 53 respondents and 3 respondents. Based on blood glucose at control, respondents with blood glucose > 200 g/dL at control were the most frequent category for low-risk, namely 40 respondents and 2 respondents for moderate-risk. Based on medications, the majority of respondents with low-risk took monotherapy drugs, namely 43 respondents, while for low-risk, 2 respondents took a combination of two OAD drugs. Based on comorbidities, both low-risk and moderate-risk had macroangiopathy comorbidities, namely 50 respondents and 3 respondents.

Table 3. Data Distribution of Major Osteoporosis Risk

Characteristics		Major Osteoporosis		
		Low-risk	Moderate-risk	Total
Gender	Man	29	0	29
	Woman	48	3	51
Age (years)	40-50	13	0	13
	51-60	32	0	32
	61-70	27	1	28
	71-80	5	1	6
	>80	0	1	1
BMI (kg/m <sup>2</sup> )	Underweight	0	1	1
	Normal	18	2	20
	Overweight	23	0	23
	Obese I	25	0	25
	Obese II	11	0	11
Duration of DM (years)	<5	24	0	24
	>5	53	3	56
Blood Glucose (mg/dL)	<200	37	1	38
	>200	40	2	42
Medications	Monotherapy	42	1	44
	2 OAD Combination	13	2	15
	OAD-Insulin	13	0	13
	Combination			
	2 Insulin-Combination	1	0	1
	3 OAD Combination	6	0	6
	2 OAD Insulin	2	0	2
Comorbidities	Combination			
	Macroangiopathy	50	3	53
	Microangiopathy	1	0	1
	Without comorbidities	26	0	26

Table 4 shows the distribution of hip fracture risk based on the baseline data of the research subjects. Based on gender, women make up the majority of the low-risk and high-risk for hip fracture, namely 44 respondents

for low-risk and 7 respondents for high-risk. Based on age, the 51-60 years age group was the largest group with a low risk of hip fracture, with as many as 31 respondents, while the high-risk was in the 71-80 years age category with 4 respondents. Based on the BMI category, the obesity I category is the largest category for low-risk hip fracture, namely 24 respondents. Meanwhile, the high-risk is in the normal and overweight categories, with 3 respondents each. For the category of the length of time the subject suffered from DM, the majority of respondents with low and high risk were with a length of DM > 5 years, namely as many as 49 respondents and 7 respondents. Based on KGD at control, respondents with KGD > 200 g/dL at control were the most frequent category for low-risk, namely 37 respondents and 5 respondents for high-risk. Based on medications, low-risk and high-risk respondents both consumed more monotherapy drugs, namely 40 low-risk respondents and 4 respondents at high risk of hip fracture. Based on comorbidities, both low-risk and moderate-risk had macroangiopathy comorbidities, which is 47 respondents and 6 respondents.

Table 4. Data Distribution of Hip Fractures Risk

Characteristics		Hip Fractures		
		Low-risk	High-risk	Total
Gender	Man	28	1	29
	Woman	44	7	51
Age (year)	40-50	13	0	13
	51-60	31	1	32
	61-70	26	2	28
	71-80	2	4	6
	> 80	0	1	1
BMI (kg/m <sup>2</sup> )	Underweight	0	1	1
	Normal	17	3	20
	Overweight	20	3	23
	Obese I	24	1	25
	Obese II	11	0	11
Duration of DM (year)	<5	23	1	24
	>5	49	7	56
Blood Glucose (mg/dL)	<200	35	3	38
	>200	37	5	42
Medications	Monotherapy	39	4	43
	2 OAD Combination	13	2	15
	OAD-Insulin Combination	12	1	13
	2 Insulin Combination	1	0	1
	3 OAD Combination	6	0	6
	2 OAD-Insulin Combination	1	1	2
Comorbidities	Macroangiopathy	47	6	53
	Microangiopathy	1	0	1
	Without comorbidities	24	2	26

#### 4. Discussion

Based on gender, this study found that the largest group of people who had T2DM were women, namely 51 respondents (63.7%). In line with research conducted by Milita, Sarah, & Bambang in [7] and research by Putri, Nugroho, & Adi in [8], the majority of people with T2DM are women. Numerous factors, including genetics, lifestyle choices, inactivity, obesity, a history of gestational diabetes, and previous delivery of babies weighing more than 4,000 grams, can contribute to the increased occurrence of type 2 diabetes in women [9]. Compared to men, women are more likely to develop. The higher occurrence of type 2 diabetes in women than in males may be due to variations in body composition and levels of sexual hormones between the sexes [10]. This is because women are more likely than males to physically experience a rise in BMI. Women will experience hormonal and psychological changes during the menstrual cycle, pregnancy, and nursing stages, which will increase their risk of type 2 diabetes. Hormonal processes make it easier for body fat to accumulate, particularly in post-menopausal women [11].

According to age, this study indicated that, with up to 32 responses, the greatest group of people with T2DM were between the ages of 51 and 60 (40 percent). This is directly proportional to previous research conducted by Putri, Nugroho, & Adi [8]. The study was conducted on 74 respondents, most patients with T2DM were in the age group 56-60 years, with as many as 21 respondents followed by the age group 51-55 years with as

many as 17 respondents. Increasing age causes a decrease in body function and can result in blood sugar instability. So, the increasing age, the greater the risk of T2DM [12]. As we age, the body's physiological function decreases due to insulin resistance or decreased secretion. As a result, the body cannot control blood sugar, which is not optimal [13].

Based on BMI, it was found that the group with the most T2DM was obesity I, with as many as 25 respondents (31.3%). In contrast to research by Irawan et al. in [14] conducted at AWS Hospital in Samarinda City in 2020, the majority of patients with T2DM are in the normal category, with as many as 49 respondents out of a total of 100 respondents. Another study, conducted by Kusnadi, Murbawani, & Fitranti in [15], showed that respondents in the obese category had a 3.8 times greater risk of suffering from T2DM compared to respondents who were not obese. People with obesity cause an increase in free fatty acids (FFA) in cells, which will decrease glucose uptake into the plasma membrane and cause insulin resistance in muscle and adipose tissue [12].

Based on blood sugar levels seen from the blood sugar value when patients came for control, most respondents had blood glucose values higher than 200 g/dL, a total of 42 respondents (52.5%). This is in line with research conducted by Antoni et al. in [16], who found that respondents with KGD > 200 g/dL were 72 respondents (75.8%) out of a total of 95 respondents. As a common chronic disease with increasing prevalence, prevention and regular treatment of T2DM is important to prevent complications, one of which is by performing glycemic control. However, differences in geographical location, socioeconomic conditions, dietary habits, and health services lead to different levels of glycemic control [17]. Factors that influence the good and bad control of diabetes are BMI, which is influenced by a person's lifestyle, such as diet, physical activity, and adherence to medication Putri, Nugroho, & Adi [8].

Based on the duration of DM, it is seen from the beginning of the patient's diagnosis by the doctor until now. From the results of this study, it was found that most respondents had T2DM with a length of DM of more than 5 years, as many as 53 respondents (66.3%). This is in line with research conducted by Cahyono & Purwanti in [18], which shows that the majority of DM patients have had DM for more than 5 years, with as many as 17 respondents (56.7%). The longer a patient suffers from T2DM will have an impact on several aspects, including psychological, physical, and social relationships, and the environment. Suffering from T2DM disease for a long time can increase the risk of vascular complications [19].

Based on the drugs consumed by patients, it is divided into monotherapy, a combination of two and three OAD drugs. Most respondents consumed monotherapy, and as many as 43 respondents (53.8%). In contrast to research conducted by Pratama & Ratnasari in [20], which showed that the majority of patients with T2DM in a private hospital in Denpasar, namely 43.32%, consumed a combination of two OAD drugs, a combination of biguanide and sulfonylurea groups. Based on PERKENI guidelines in [21], the indication for OAD is when the patient's blood sugar level fails to be controlled with non-pharmacological therapy. If within 4-8 weeks the patient has carried out non-pharmacological therapy in the form of lifestyle modification, but the blood sugar levels are still higher than 200 mg/dL and HbA1C > 8%, the patient is advised to start treatment with OAD drugs. If therapy with OAD drugs is not adequate in controlling blood sugar levels, it is an indication to give single or combination insulin.

With up to 48 respondents, the macroangiopathy comorbidity in the form of hypertension is the one with the greatest number of respondents when it comes to comorbidities (60 percent). This is exactly in line with the study by Tampa'I et al [22]. regarding the proportion of comorbidities in T2DM patients at Tuminting Health Center in January-June 2019. The results showed that the most common comorbidity suffered by T2DM patients was cardiovascular disorders, which included hypertension, namely 32 respondents (24.42%) out of a total of 132 respondents. In T2DM, hyperglycemic events cause intravascular fluid resistance, which results in an increase in body fluid volume and is followed by damage to the vascular system, which causes an increase in peripheral arterial resistance; both conditions are the basis for hypertension. In the long term, hypertension, followed by further vascular damage, will lead to complications of cardiovascular disease and chronic kidney disease (CKD), which are the leading causes of death [23].

The findings of the FRAX tool value computation will display the risk of hip fracture and serious osteoporosis. A total of 77 respondents had low-risk (<10 percent) results from the FRAX calculation about their risk of significant osteoporosis (96.3 percent). Out of 72 respondents, the majority have a hip fracture risk of less than 3 percent, according to the results of the FRAX tool calculation (90 percent). This is consistent with studies carried out by Valentini, et al [24], which say that FRAX values tend to be higher in nondiabetic subjects than those with DM. However, patients with T2DM tend to have higher BMD and T scores compared to nondiabetic subjects.

It is advised that high-risk individuals do a bone mineral density examination (BMD) as a standard measurement for osteoporosis diagnosis and fracture risk assessment after receiving the findings of the FRAX



calculation. Patients at high risk should begin both lifestyle modification and pharmacological therapy if their FRAX scores are greater than 20% for severe osteoporosis and greater than 3% for hip fractures. The two types of osteoporosis pharmaceuticals are distinguished by their method of action: anabolic agents, which enhance bone mass, and antiresorptive agents, which reduce bone mass loss [25]. Respondents at moderate risk for major osteoporosis (FRAX value 10-20%) require careful evaluation to identify fractures, for example, by performing x-rays or by paying attention to risk factors that may contribute, which in turn can be a consideration for pharmacological therapy [26].

Respondents with hip fractures (FRAX value <3%) and significant osteoporosis (FRAX value <10%) in the low-risk category concentrated on osteoporosis prevention. A few strategies to prevent osteoporosis include ensuring that bones receive the necessary amounts of calcium and vitamin D, exercising frequently, abstaining from alcohol and tobacco, consuming less caffeine and soda, and having an early osteoporosis screening, particularly for postmenopausal women. [26].

## 5. Conclusion

In the T2DM patients in Haji Hospital Medan, based on the FRAX tool calculation (without BMD), most of the patients are at low risk of major osteoporotic and hip fractures. After obtaining the results of the FRAX calculation, people with risk fractures are recommended to perform BMD assessment as a standard measurement for osteoporosis diagnosis and fracture risk assessment.

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