**Journal of Medical and Health Studies (JMHS)**
ISSN: 2710-1452
DOI: 10.32996/jmhs
Journal Homepage: www.al-kindipublisher.com/index.php/jmhs

JMHS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

**| RESEARCH ARTICLE**

# Epidemiological profile, as determined by the frax tool, of patients with type 1 diabetes *mellitus* followed at a referral hospital in Belém

**Claudio Henrique Simões Neto[1]✉, Biatriz da Silva Rodrigues[2], Haroldo Gomes Ferreira Filho[3], Juliana Leite de Oliveira[4], Felipe Eugênio Leal da Cunha[5], Karem Miléo Felício[6], João Soares Felício[7], Natércia Neves Marques de Queiroz[8]**

*[1]Medical Doctor, Federal University of Pará (UFPA), Brazil;*
*[2]Medical Student, Federal University of Pará (UFPA), Brazil;*
*[3]Medical Doctor, Federal University of Pará (UFPA), Brazil;*
*[4]Medical Doctor, Federal University of Pará (UFPA), Brazil;*
*[5]Medical Doctor, Federal University of Pará (UFPA), Brazil;*
*[6]Ph.D. in Oncology and Medical Sciences. Department of Endocrinology, Metabolism, and Diabetes at João de Barros Barreto University Hospital, Federal University of Pará (UFPA), Brazil;*
*[7]Ph.D. in Endocrinology, Department of Endocrinology, Metabolism, and Diabetes at João de Barros Barreto University Hospital, Federal University of Pará (UFPA), Brazil;*
*[8]Ph.D in Oncology and Medical Sciences. Department of Endocrinology, Metabolism, and Diabetes at João de Barros Barreto University Hospital, Federal University of Pará (UFPA), Brazil*

**Corresponding Author**: Claudio Henrique Simões Neto, **E-mail**: claudiosneto10@gmail.com

**| ABSTRACT**

This study evaluated the FRAX tool as a screening strategy for osteoporotic fractures in people with type 1 diabetes mellitus (T1DM), in comparison with bone mineral densitometry. It also described the epidemiological profile of these patients. This was an observational, cross-sectional study conducted at the Endocrinology Outpatient Clinic of the João de Barros Barreto University Hospital in Belém, Pará, Brazil. The sample comprised 15 patients with T1DM aged 40–90 years. Patients were excluded if they had secondary or previously diagnosed osteoporosis, were undergoing osteoporosis treatment or chronic corticosteroid therapy, or had advanced chronic kidney disease. A standardized questionnaire gathered demographic, anthropometric, clinical, family history, and laboratory data. The 10-year fracture risk was estimated with two versions of FRAX (ABRASSO and University of Sheffield), and bone densitometry results were analyzed when available. Mean age was 48 years, 60% of participants were female, and mean BMI was 28.8, with 80% overweight or obese. Mean diabetes duration was 25 years. Diabetes complications affected 80% of patients, with retinopathy, hypertension, and nephropathy each present in 46%. A personal history of fractures was reported by 33% and a family history of fractures by 53%. Mean fasting glucose was 144 mg/dL and mean HbA1c was 9.75%, indicating inadequate glycemic control. According to the University of Sheffield FRAX, 93% of participants were low risk and 7% intermediate risk. According to the ABRASSO FRAX, 80% of the patients who could be assessed were intermediate risk. Densitometry was available for only three participants and varied widely, including one case of spinal osteoporosis. The sample showed a long disease course, poor glycemic control, and multiple risk factors for fractures. The discrepancy between the two FRAX versions suggests possible underestimation of fracture risk in T1DM (Sheffield) or overestimation (ABRASSO). The low incidence of T1DM, the small sample, and the few densitometry results limit the conclusions. Larger studies are needed to confirm the usefulness of FRAX in this population.

**| KEYWORDS**

Type 1 diabetes mellitus; FRAX; osteoporotic fractures; bone mineral density; fracture risk screening.

**| ARTICLE INFORMATION**

**ACCEPTED:** 19 October 2026 **PUBLISHED:** 17 November 2026 **DOI:** 10.32996/jmhs.2026.7.12.2

**Copyright**: © 2026 the Author(s). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) 4.0 license (https://creativecommons.org/licenses/by/4.0/). Published by Al-Kindi Centre for Research and Development, London, United Kingdom.

## 1. Introduction

Diabetes mellitus (DM) is an endocrine-metabolic disorder characterized by a state of persistent hyperglycemia resulting from a defect in insulin secretion or action, which impairs the metabolism of carbohydrates, lipids, and proteins.

It can be classified into four main groups, according to the etiology of the disease: Type 1 DM, Type 2 DM, gestational DM, and other specific types of DM[1].

Type 2 diabetes mellitus is the most prevalent, accounting for approximately 90–95% of cases, followed by Type 1 DM, with approximately 5–10%[2]. DM can cause complications affecting various systems, such as cardiovascular, renal, ophthalmic, and skeletal disorders; these complications are responsible for significant morbidity and mortality among patients, thus representing a major burden on the healthcare system and resulting in substantial financial losses[1].

Osteoporosis, one of the complications of diabetes mellitus (DM), is a disease characterized by a reduction in bone mass, which can be highly debilitating both physically and psychologically, mainly due to an increased risk of falls and fractures, resulting in pain, impaired function, and a reduced quality of life. Several studies have already demonstrated the association between diabetes mellitus and osteoporosis, and it is now well established that type 1 and type 2 diabetes are associated with an increased risk of osteoporotic fractures, primarily due to increased bone fragility, with several complex mechanisms involved in this process[3,4,5].

FRAX (Fracture Risk Assessment Tool®) was developed by the University of Sheffield in the United Kingdom through the Center for Metabolic Bone Diseases, in collaboration with the World Health Organization (WHO), with the aim of estimating patients' 10-year fracture risk, regardless of bone mineral density (BMD) values, and identifying therapeutic intervention groups. In this context, several variables are analyzed to estimate this risk, such as: country of residence, age, weight, height, sex, and clinical factors (previous fracture, family history of fracture, glucocorticoid use, smoking, alcohol abuse, rheumatoid arthritis, and secondary causes of osteoporosis). As a result, the absolute risk of fracture for an individual over a 10-year period is estimated—that is, all aspects of fracture risk analysis are taken into account—including both physical factors and the clinical and personal factors of each patient[6].

It is clear that the pathophysiology of diabetes and its vascular changes are risk factors for fragility fractures. Although some mechanisms are not fully understood, it can be stated that hyperglycemia reduces bone mineral density, increasing the risk of fracture—primarily because hyperglycemia alters osteoblast activity. In addition, patients with diabetes have a higher risk and frequency of falls due to changes in proprioception caused by peripheral neuropathy, macular edema, cataracts, postural hypotension, or adverse effects of medications such as thiazolidinediones[7].

Thus, changes in the FRAX score would be expected to correspond to the substantial increase in the risk of falls among diabetic patients due to the factors mentioned. Contrary to this line of thinking, it has been observed that FRAX underestimates the risk of fragility fractures in these patients because it does not specifically assess important disease parameters—such as blood glucose levels, the presence or absence of vascular or neurological changes in diabetic patients, and the medications they are taking. Thus, evaluating how these patients fare on the FRAX is of paramount importance for identifying an epidemiological profile of people with diabetes who are at higher risk of developing osteoporotic fractures, as well as for establishing the correct management strategy for diabetic patients and ensuring that their fracture risk is not underestimated[8].

The objective of this study is to evaluate the FRAX tool as a screening strategy for osteoporotic fractures among people with Type 1 Diabetes Mellitus in comparison with bone mineral densitometry.

## 2. Methodology

This is a cross-sectional study (case-control + observational + cross-sectional). It was conducted at the Endocrinology Outpatient Clinic of the João de Barros Barreto University Hospital (HUJBB) in Belém, Pará.

Regarding ethical considerations, the project was approved by the HUJBB Institutional Review Board (IRB). By signing the Researcher's Declaration of Responsibility, the researchers commit to maintaining absolute confidentiality regarding all information collected, using it exclusively for scientific research purposes, and respecting and adhering to the standards established by the National Health Council in Resolution 196/96 for the regulation of research involving human subjects. Furthermore, there was no discrimination in the selection of individuals who participated in the study, and the inclusion and exclusion criteria described in this paper were respected. The selected group was invited to participate in the study and was informed of the objectives, risks, and benefits of the research, as well as the Informed Consent Form (ICF), which was read by the

participants or by a companion. The decision of any individual to participate was fully respected in accordance with the principles of beneficence and non-maleficence, and participants were free to withdraw from the study at any time without penalty.

The study population consisted of individuals with type 1 diabetes mellitus who were being treated at the aforementioned outpatient clinic. The inclusion criteria were:

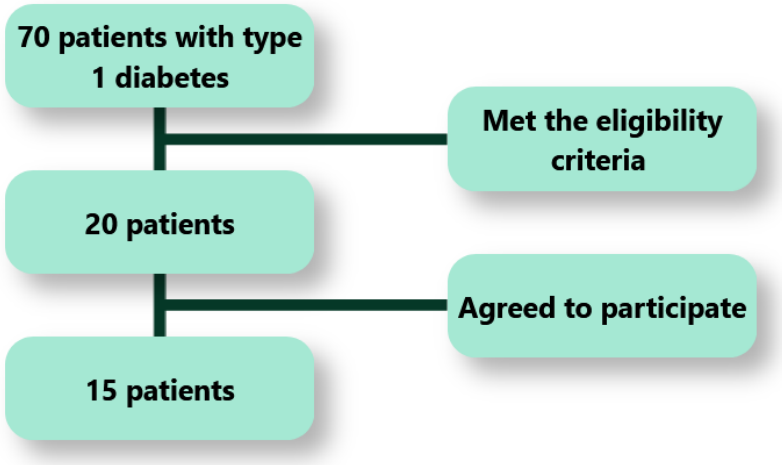
- Having type 1 diabetes mellitus;
- Being between 40 and 90 years of age.

Meanwhile, the exclusion criteria were:

- Individuals diagnosed with secondary osteoporosis;
- Individuals with a previous diagnosis of osteoporosis;
- Individuals undergoing treatment for osteoporosis;
- Individuals on chronic corticosteroid therapy;
- Individuals with chronic kidney disease (CKD) with a clearance rate < 30.
- The sample consisted of 15 patients with DM1.

**Figure 1**

*Participant selection flowchart.*




Regarding data collection, patients who agreed to participate in the study after reading, having the Informed Consent Form (ICF) explained to them, and signing it were administered a standardized questionnaire. The variables of interest analyzed were divided as follows:

- Demographic and anthropometric information: Identification number, age, sex, skin type, weight, and height.

- Personal medical history: History of fractures, previous diagnoses (rheumatoid arthritis, secondary osteoporosis, diabetic retinopathy, diabetic nephropathy, peripheral arterial disease, systemic hypertension), other comorbidities, duration of diabetes, smoking and/or alcohol use, calcium intake, sun exposure, and medications currently being taken.

- Family history: History of fractures and history of osteoporosis.

- Laboratory parameters and ancillary tests: Complete blood count (red blood cells, hemoglobin, hematocrit, RDW, MCV, MCH, MCHC, white blood cells, and platelets), urea, creatinine, AST, ALT, total cholesterol and its fractions, triglycerides, TSH, free T4, PTH, calcium profile (total calcium, ionized calcium, phosphorus, and magnesium), vitamin D, fasting blood glucose, glycated hemoglobin (HbA1c), and presence or absence of microalbuminuria, bone densitometry (if available), including T-score, Z-score, and BMD.

Following this, the FRAX tool was applied, and feedback was provided to the participant, along with a copy of the test results. Finally, the information obtained was forwarded to the attending physician so that he or she could follow up on the patient's care, if necessary. An example of this is the request for bone mineral density testing in the case of patients at intermediate risk.
The collected data were tabulated in Microsoft Excel and, during the data analysis phase, statistically analyzed using BioEstat, Jamovi, SigmaStat, and SPSS, where specific and appropriate tests were performed for each analyzed variable; the results were subsequently presented in tables and/or graphs, depending on which format was most suitable for presenting and explaining the findings.

Among the potential risks to study participants is the risk of a breach of privacy resulting from negligent handling by the researchers of the information collected through the questionnaire and the use of the FRAX tool. This risk will be minimized by restricting access to the data to the researchers only, thereby maintaining the participants' anonymity. For the scientific community, there is a risk of publishing unreliable or biased data if the sample size is not sufficient; this will be avoided through ongoing statistical and methodological reviews.

As for the benefits to the researchers, these will lie in gaining new knowledge regarding the epidemiological profile—as determined by the FRAX tool—of people with Type 1 Diabetes Mellitus, information that can be used to improve the screening and management of osteoporosis as a complication of this disease. Participants will benefit from the study by receiving information about the possible complications of diabetes mellitus, as well as their prevention and management.

In addition, they will be participating in an active screening program for osteoporotic fractures, which allows for early intervention if necessary. The scientific community will benefit from this study, as it will contribute to expanding the available scientific knowledge on the subject by revealing the 10-year risk of osteoporotic fractures in people with diabetes. Consequently, new questions may arise, encouraging the scientific community to conduct further research on this topic.

### *3. Results/Findings*

As for the results, data were collected from a total of 15 people with diabetes. The study participants had a mean age of 48 years; 60% were female and 40% were male. The mean weight of the participants was 73.7 kg and the mean height was 159.6 cm, with a mean BMI of 28.8. Among the participants, 20% had a BMI within the normal range, 53% were overweight, 20% had Class I obesity, and 7% had Class II obesity. Approximately 33% reported a personal history of fractures. Complications of diabetes mellitus, as well as other comorbidities, were observed in 80% of the patients, with diabetic retinopathy present in 46% of cases, systemic arterial hypertension (SAH) in 46%, diabetic nephropathy in 46%, peripheral arterial disease (PAD) in 20%, and rheumatoid arthritis in 6%. The average duration of DM among participants is 25 years. There were no reports of smokers, while 13% are alcoholics.

**Table 1**

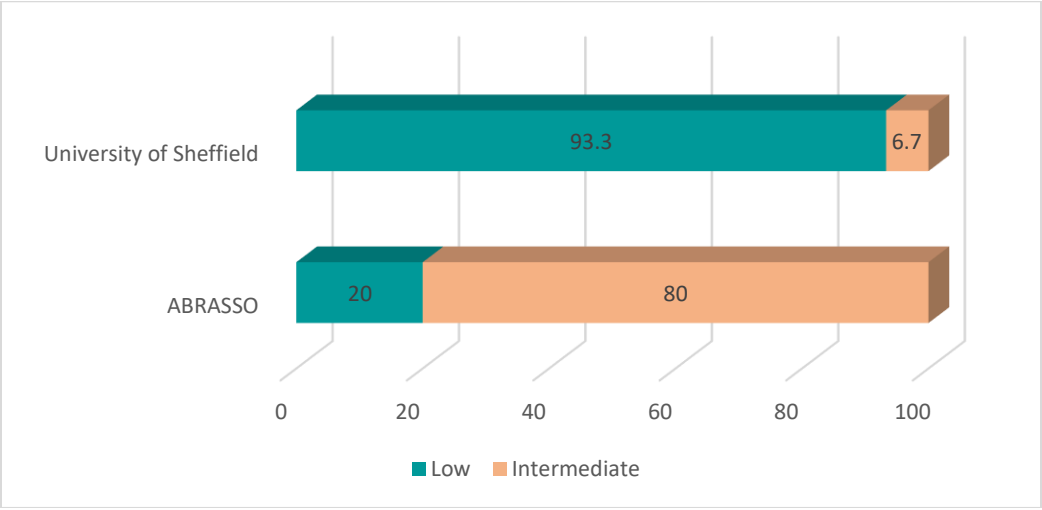
*Demographic, anthropometric, and personal history information*

| Datas | Results |
|---|---|
| **Average Age** | 48 years |
| **Sex** | |
| **Male** | 40% |
| **Female** | 60% |
| **Average Weight** | 73.7 kg |
| **Average Height** | 159.6 cm |
| **Average BMI** | 28.8 |
| **Normal** | 20% |
| **Overweight** | 53% |
| **Class I obesity** | 20% |
| **Class II obesity** | 7% |
| **Personal history of factures** | 33% |
| **Complication of DM** | 80% |
| **Retinopathy** | 46% |
| **Hypertension** | 46% |
| **Nephropathy** | 46% |
| **DAOP** | 20% |
| **Rheumatoid arthritis** | 65 |
| **Average duration of diabetes** | 25 years |
| **Ethylism** | 13,333% - 2 patients in total |

Other risk factors include low calcium intake in 6% of cases, and 40% reported low sun exposure. In addition, 53% have a family history of fractures and 33% have a family history of osteoporosis. The mean fasting blood glucose level is 144 mg/dL, and the mean HbA1c is 9.75%. Regarding fracture risk assessed by FRAX, the ABRASSO and University of Sheffield tools were used. This was necessary because ABRASSO, whose tool was used at the start of the study, began a prolonged maintenance period for its tool. That said, according to the ABRASSO tool, 80% of the patients—for whom this tool can be used, given that it is currently undergoing maintenance—were classified as Intermediate Risk, requiring a bone densitometry test. Furthermore, according to the University of Sheffield, 93% of the participants—in this case, all those who took part in the study, since the calculation was performed again—fall into the low-risk category, and 7% into the intermediate-risk category.

**Figure 2**

*10-Year Fracture Risk According to the University of Sheffield and ABRASSO*



Regarding the densitometric results, one participant was found to have osteoporosis in the spine, with bone density significantly below normal, as well as a femur with normal to slightly reduced bone density, which did not meet the criteria for osteoporosis. Furthermore, one participant had bone density in the spine and femur within the normal range, with no signs of osteopenia or osteoporosis. Finally, one patient had bone density significantly above average in both the spine and the femur. This data is available in Table 2.

**Table 2**

*Densitometric results*

| Scores | Patient A | | Patient B | | Partient C | |
|---|---|---|---|---|---|---|
| | Spine | Femur | Spine | Femur | Spine | Femur |
| **T-Score** | -3.1 | -0.9 | -0.3 | -0.1 | 3.2 | 2.2 |
| **Z-Score** | -2.0 | -0.2 | 0.2 | -0.1 | 4 | 2.7 |

The main objective is to write a scientific article for publication in an indexed journal, using the data obtained in the current project. In addition, the data were used to prepare an abstract to be presented at the Brazilian Congress of Endocrinology and Metabolism[9].

The challenges faced stem from the low incidence of Type 1 diabetes, which accounts for about 10% of diabetes mellitus cases, as reported by the Ministry of Health.

This results in a small number of patients diagnosed with Type 1 diabetes, especially among those over 40 years of age. Furthermore, it was found that, during the project's proposed timeframe, few of the requested bone densitometry tests were returned for analysis by the project.

Another obstacle encountered during the project was the prolonged unavailability of the FRAX tool on the ABRASSO (Brazilian Association of Bone Assessment and Osteometabolism) website, which necessitated the use of the FRAX tool from the Centre for Metabolic Bone Diseases at the University of Sheffield, UK. As a result, it was necessary to reevaluate the fracture risk results, as there were discrepancies between the analyses performed using the FRAX tool on the ABRASSO website and those performed using the University of Sheffield's tool.

## *4. Conclusion*

This study revealed important aspects regarding the clinical profile and risks associated with patients with Type 1 Diabetes Mellitus. The mean age was relatively young for the scope of the study, given that the minimum age requirement was 40 years, while the mean age of the participants was 46 years. There is a predominance of females (60%). The average weight of the patients is 73.7 kg, and the average height is 159.6 cm; however, the average BMI is 28.8, with a significant prevalence of overweight and obesity. A personal history of fractures was present in 33% of the participants, indicating a notable but not statistically significant prevalence. In contrast, complications of DM were widely observed, notably diabetic retinopathy (46%), hypertension (46%), and diabetic nephropathy (46%), as well as peripheral arterial disease (20%) and rheumatoid arthritis (6%). The average duration of DM, from the time of diagnosis, is 25 years, indicating a long disease course in the observed sample. Risk factors such as smoking and alcohol consumption are low, reported in 0% and 13% of cases, respectively.

This finding is relevant, given that alcohol consumption and smoking are risk factors associated with fractures, as are decompensation and a history of chronic microvascular and macrovascular diseases.

Additional risk factors, such as low calcium intake and low sun exposure, were identified in 6% and 40% of patients, respectively, highlighting the need for behavioral counseling to promote lifestyle changes (LSC) among patients, especially when considered in conjunction with the metabolic factors observed—namely, a high prevalence of overweight and obesity. Family histories of fractures and osteoporosis are also prevalent, accounting for 53% and 33% of cases, respectively. Assessments of blood glucose and HbA1c levels indicated mean values of 144 mg/dL and 9.75%, respectively. This indicates—primarily based on the analysis of the mean HbA1c value—that glycemic control is outside target ranges, which contributes to microvascular and macrovascular complications, as well as to the risk of bone complications. It is important to note the disparity between the mean fasting blood glucose levels and the mean HbA1c levels, which may indicate behavioral changes around the time of testing.

The fracture risk assessment using the University of Sheffield's FRAX model showed that 93% of patients are at low risk, while 7% are at intermediate risk, indicating a possible underestimation of fracture risk in patients with type 1 diabetes. In contrast, the fracture risk assessment using the ABRASSO FRAX model—although it did not include all participants—showed that 80% of patients are at intermediate risk, while 20% are at low risk. This may indicate an overestimation of fracture risk in patients with type 1 diabetes.

The densitometric results, particularly due to the small sample size, indicated significant variations in bone density among patients, with cases of osteoporosis in the spine and normal to slightly reduced bone density in the femur in one patient, normal bone density in another patient, and above-average bone density in a third patient.
When discussing the difficulties encountered, the low incidence of Type 1 diabetes stands out, resulting in a small number of patients available for the study—especially given the study's specific scope, which requires patients to be over 40 years of age, as this is the age range for which the FRAX tool provides evidence. Furthermore, the small sample size hinders an efficient epidemiological analysis of the patients' densitometric profile. It is important to note that ABRASSO's prolonged use of the FRAX tool led to the need to use the University of Sheffield's FRAX tool, which resulted in disparities in fracture risk analyses.

In contrast to the low prevalence of intermediate risk and high prevalence of low risk in the University of Sheffield tool, it can be observed that the ABRASSO tool yielded a higher number of results indicating intermediate risk for fractures.

**Statements and Declations**

**Funding:** The APC was funded by Federal University of Pará, Brazil, with FAPESPA, SAEST, and CNPq.
The authors declare no conflict of interest.

**References**

[1] American Diabetes Association. (2023). *Standards of Care in Diabetes*. Virginia:Diabetes Care.

[2] Sociedade Brasileira de Diabetes. (2019). *Diretrizes da Socieade Brasileira de Diabetes 2019-2020.* São Paulo.

[3] Jiang, N., Xia, W. (2018). Assessment of bone quality in patients with diabetes mellitus. *Osteoporosis International, 29(*8), 1721-1736.

[4] Shah, V. N., Shah, C. S., & Snell-Bergeon, J. K. (2015). Type ' diabetes and risk of fractures: meta-analysis and review of the literature. *Diabetic Medicine, 32(*9), 1134-1142.

[5] Thong, E. P., Herath, M., Weber, D. R., Ranasinha, S., Ebeling, P. R., Milat, F., & Teede, H. (2018). Fracture risk in young and middle-aged adults with type 1 diabetes mellitus: a systematic review and meta-analysis. *Clinical Endocrinology, 89(*3), 314-323.

[6] Zerbini, C. A. F. (2019). FRAX Modelo Brasil: um texto clinico explicativo sobre limiares para intervenção terapêutica. *Diagn Tratamento, 24(*2), 41-49.

[7] Antonopoulou, M., Bahtiyar, G., Banerji, M. A., & Sacerdote, A. S. (2013). Diabetes and bone health. *Maturitas, 76(*3), 253-259.

[8] Giangregorio, L. M., Leslie, W. D., Lix, L. M., Johansson, H., Oden, A., McCloskey, E., & Kanis, J. A. (2012). Frax underestimates fracture risk in patients with diabetes. *Journal of Bone and Mineral Research, 27(*2), 301-308.

[9] American Diabetes Association. (2024). *Standards of care in Diabetes.* Virginia: Diabetes Care.