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الجمعية السعودية لجراحة العظام
Saudi Orthopedic Association

Journal of Musculoskeletal Surgery and Research

Original Article

Assessment of fracture risk among postmenopausal Sudanese women: Is the fracture risk assessment score beneficial?

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Received: 27 January 2023
Accepted: 21 May 2023
Epub Ahead of Print: 12 June 2023
Published: 31 July 2023

DOI
10.25259/JMSR_23_2023

Quick Response Code:

ABSTRACT

Objectives: Osteoporosis leads to fragile bones with a high risk of fracture. Moreover, a bone mineral density test has low sensitivity to predict fractures. Alternatively, the World Health Organization fracture risk assessment (FRAX) tool helps improve the prediction of fractures in women even before they develop osteoporosis. This study aimed to assess the risk of developing fractures in Sudanese women using the FRAX tool by studying clinical risk factors that lead to decreased bone strength.

Methods: A cross-sectional community-based study was conducted in the River Nile State, Sudan (Jan 2020–June 2020). A questionnaire comprising demographic data and clinical risk factors of fragility fracture was used to determine whether these factors met the FRAX criteria.

Results: Participants were 350 postmenopausal women between the ages of 51–60 (36%), with a body mass index (BMI) >25 in 61.4%. In addition, 11% were exposed to oral glucocorticoids, and premature menopause occurred among 20.3%. The risk of major osteoporotic fracture was highest (>20%) in approximately 7% of the women, and 16.3% of them had a high risk of hip fracture (>3%). The risk for fractures increases with age, and a lower BMI is significantly associated with minimal trauma fractures. This study observed significant relationships among systemic glucocorticoid use, insulin-dependent diabetes mellitus, premature menopause, and osteoporotic fractures. All significant associations had $P < 0.05$.

Conclusion: This study observed that multiple risk factors significantly correlated with osteoporotic fractures. Therefore, the FRAX tool is useful in 10-year fracture risk predictions.

Keywords: FRAX score, Osteoporotic fracture risk factors, Major osteoporotic fracture, Hip fracture, Sudan

INTRODUCTION

Osteoporosis is characterized by reduced bone quality and density, leading to fragile bones with a high risk of fracture even after a minor fall. The most common bones usually affected are the

How to cite this article: Noor SK, Mohammed MS, Farah AM, Farah SI, Mohammed FB, Bushara SO. Assessment of fracture risk among postmenopausal Sudanese women: Is the fracture risk assessment score beneficial? J Musculoskelet Surg Res, 2023;7:191-7.

spine, hip, pelvis, wrist, and upper arm.[1] Although millions of people worldwide have osteoporosis, it is still underdiagnosed. Hence, it is considered a silent epidemic, as it is relatively pain-free and, unfortunately, leads to serious complications that impact the quality of life of patients and relatives.[2]

Several studies have addressed osteoporosis and observed the serious risk factors correlated with osteoporosis in the past 15 years.[3,4] One unfortunate finding is that only a small number of women received appropriate medications even following a fragility fracture.[5] Moreover, only one out of three vertebral fractures was clinically diagnosed.[6] This disease has high morbidity, with an estimation of higher than 8.9 million annual fractures.[7]

Due to the major concern and lack of previous experience in dealing with osteoporosis, as national governments did not prioritize it, the World Health Organization (WHO) fracture risk assessment (FRAX) tool was accredited in about 60 countries. Unfortunately, Sudan is not one of them yet. This tool makes it easier to identify people at risk of fracture, particularly those areas with no facilities to check their bone mineral density (BMD).[8] Moreover, BMD measures the quantity of bone density, not the quality; thus, it might have low sensitivity to predict fractures.[9]

The FRAX tool calculates a 10-year probability of a major osteoporotic fracture (MOF) or a hip fracture (HF) with or without considering the BMD. This tool helps improve the prediction of fractures in women even before they develop osteoporosis.[10] Modifiable risk factors, such as current smoking and alcoholism, and non-modifiable factors, such as age and gender, in addition to several other independent risk factors, are all addressed in its calculation.[11]

According to different studies, FRAX score calculation with and without BMD provides the same fracture risk prediction.[12,13] The probability of fracture estimated by the tool is based on the country's epidemiology; therefore, it differs in various world regions. Furthermore, the International Osteoporosis Foundation (IOF) consolidates its international use to make fracture protection a pressing issue worldwide.[14] In Sudan, many women tend to increase their weight using dexamethasone tablets, which might increase the risk of osteoporotic fractures. Moreover, we believe that there is irrational use of steroids in rheumatological diseases, which may make Sudan differ in epidemiology.

This study aimed to calculate the risk of postmenopausal Sudanese women developing fractures using the FRAX score to put a set action toward these women.

MATERIALS AND METHODS

A descriptive cross-sectional community-based household study was conducted in a house-to-house survey from January 2020 to June 2020. The population of this study is composed of those who live in Atbara City, north Sudan, where a large number of people have moved in recent years due to mining. A random sampling strategy was used, which was a multistage cluster. First, the study participants were selected from urban locations. North, West, South, and East were the four geographic divisions of the city. Then, two districts were chosen from each geographic area using a simple tossing technique. The number of homes was chosen in proportion to the population size. Starting at house number three on the district's main street, a survey (house-to-house) was done. Families who declined to participate or vacant homes were replaced by the home next door.

Postmenopausal Sudanese women permanently residing in Atbara City were included in the study. Patients already diagnosed with osteoporosis and receiving treatment, premenopausal women, rural residents, and temporal residents were excluded from the study.

Sample size

The sample size for the study was calculated by the formula: $n = z^2\ pq/d^2$ and the final estimated sample size was 385 participants. The respondent rate was 91%, and 9% ($n = 35$) were non-respondents excluded from the study.

Data collection tool

A structured interview questionnaire was used to collect data from subjects who participated in the study. The questionnaire was adopted from the WHO-stepwise approach for non-communicable disease surveillance. This questionnaire gathered demographic, behavioral information, and physical measurements, including anthropometric measurements.

The questionnaire includes the following:

1. History: Name, age, smoking, and alcoholism
2. Clinical examination: Weight and height to calculate body mass index (BMI)
3. In addition to risk factors of osteoporosis and other causes of osteoporosis.

Data analysis

The collected data were analyzed by computer using the Statistical Package for the Social Sciences version 23. In this study, $P = 0.05$ was considered statistically significant, reflecting the correlation between independent variables and osteoporosis. This study used risk stratification of the FRAX score result as a cutoff value. For MOFs, ≥20%, 10–20%, and <10% were used as a cutoff value for high, moderate, and low risk, respectively, and for HFs, (≥3%) and (<3%) used as a cutoff value for high and low risk, respectively.[15]

Variables

The dependent variable was the FRAX tool (without dual X-ray absorptiometry [DEXA]), which depends on factors contributing to osteoporosis. The independent variables were age, gender, fragility fracture history, family history of the first-degree relative of osteoporosis-related fracture, smoking history, alcohol intake, and other causes of osteoporosis which are components of the FRAX tool.

RESULTS

The analysis was based on data from 350 postmenopausal women living in River Nile State to assess screening for osteoporosis with the WHO FRAX score. Participants' ages ranged from 40 to 90 years (mean: 55.988), of which approximately 33% (n = 118), 36% (n = 127), and 22% (n = 79) were aged between 40–50, 51–60, and 61–70, respectively [Table 1].

Most participants were overweight, with 61.4% (n = 215) having a BMI above 25, and only 4.9% (n =17) were underweight [Table 1]. The number and proportion of women with a previous fragility fracture were 24 (6.9%) from 350 women. After analyzing the total number of participants, we identified 22 women (6.3%), one of whose parents had a HF.

A total of 40 women (11%) were exposed to oral glucocorticoids. In addition, 53 women (15.1%) were diagnosed with rheumatoid arthritis (RA), and 21 women (6%) complained of insulin-dependent diabetes mellitus (IDDM). Notably, 71 women (20.3%) had premature menopause, representing a clear prevalence of a significant risk factor for osteoporosis [Table 1].

The risk of MOF is highest in approximately 7% (n = 24) of the women, and 18.6% (n = 65) have an intermediate risk. In addition, 16.3% (n = 57) of the women have a high risk of HF, which indicates the need for treatment recommended by the WHO according to the FRAX questionnaire. Furthermore, 83.7% (n = 293) have a mild-to-moderate risk of HF; the mean is 1.98 and SD is 0.11 [Table 2].

With advancing age, the incidence of fractures increased in various fracture sites [Table 1]. As age increases, the risk for HF, vertebral fractures, and all osteoporotic fractures combined increase, especially at the age of 60 and above.

Lower BMI is significantly associated (P = 0.001) with minimal trauma fractures, particularly MOF, while fracture risk decreased with a higher BMI [Table 3].

Moreover, a significant relationship was seen between a previous fragility fracture and the incidence of future fractures, with P=0.004 and 0.000 for HF and MOF, respectively [Table 3]. As demonstrated in above-mentioned tables, a significant P-value regarding the correlation between parent HF and MOF is addressed in our study. More than 30% and 18.2% of participants whose parents had a history of HF have a significant association with 10–19% and >20% of the risk of MOF, respectively.

Table 1: Sociodemographic and characteristics of participants.

Category	Frequency	Percentage
Age		
40–50	118	33.7
51–60	127	36.3
61–70	79	22.6
71–80	16	4.6
81–90	10	2.9
Body mass index		
<18	17	4.9
18–25	118	33.7
>25	215	61.4
Previous fragility fracture		
Yes	24	6.9
No	326	93.1
Parent hip fracture		
Yes	22	6.3
No	328	93.7
Oral glucocorticoid use		
Yes	40	11.4
No	310	88.6
Rheumatoid arthritis diagnosis		
Yes	53	15.1
No	297	84.9
Insulin-dependent diabetes mellitus		
Yes	21	6
No	329	94
Untreated long-standing hyperthyroidism		
Yes	4	1.1
No	346	98.9
Premature menopause		
Yes	71	20.3
No	279	79.7
Hypogonadism		
Yes	8	2.3
No	350	79.7
Malabsorption		
Yes	3	0.9
No	347	99.1
Chronic liver disease		
Yes	7	2
No	343	98
Chronic malnutrition		
Yes	3	0.9
No	347	99.1
Osteogenesis imperfecta		
Yes	5	1.4
No	345	98.6
Alcohol 3 or more units per day		
Yes	0	0
No	350	100

Table 2: Risks of major osteoporotic fractures and hip fractures among participants.

	Frequency	Percentage
Major osteoporotic fracture		
<10%	261	74.6
10–19%	65	18.6
>20%	24	6.9
Hip fracture		
<3%	293	83.7
>3%	57	16.3

Regarding systemic glucocorticoid use, the findings revealed a statistically significant difference ($P < 0.05$) between exposure to systemic glucocorticoids and fragility fracture incidence. Those findings were evident for both HF and MOF [Table 3].

Fifty-three (15.1%) patients were diagnosed with RA, leading to a marked increase in the possibility of fractures; 24 (45.3%) out of 53 were eligible for osteoporosis treatment, as they were at high risk for HF, even without the DEXA scan evaluation for BMD [Table 3].

A statistically significant difference ($P < 0.05$) between HF/MOF and IDDM, premature menopause, malabsorption, and osteoporotic fractures are addressed in our study [Table 3].

A small number of participants, 2% ($n = 7$), had chronic liver disease (CLD), which is insignificantly correlated with osteoporotic fractures. In addition, five women (1.4%) were diagnosed with osteogenesis imperfecta, and again *P*-value was insignificant regarding the correlation between it and osteoporotic fracture.

DISCUSSION

Osteoporosis is the most common metabolic bone disease,[16] affecting more than a third of postmenopausal women.[17] This study's results show that the FRAX tool is helpful for the assessment of osteoporosis, and this is consistent with a Palestinian study done to evaluate FRAX performance in predicting fracture risk.[18]

A major strength of the tool is that it can predict fracture risk for 10 years. Therefore, the results provide an index of the usefulness of this prognostic model. To the best of our knowledge, our study is the first to use the FRAX tool prediction in Sudan.

The survey results of 350 women (done without a DEXA scan) revealed a significant association between increasing age and increased risk of both HF and MOF. This has been established in the previous studies.[19-21]

The age effect was most evident in the 70s–90s age group. Due to the increase in age, estrogen levels, calcium, and vitamin D are reduced. Thus, bone density naturally decreases, which is a serious risk for fragility fractures. Loss of estrogen results in favor of osteoclasts relative to osteoblasts because estrogen normally induces apoptosis of osteoclasts.[22]

As addressed in Vestergaard's study,[23] the BMI is an observed risk factor for future fractures. Our data which is consistent with the previously mentioned study showed a significant link between a low basal index and a high risk of fragility fracture. This may be due to muscle weakness and associated reduction in vitamin D and protein levels, all contributing to the increased liability of falling.[24] In addition to the above clinical risk factors, it also found a significant link between previous HF and the risk of minimal trauma fracture. Our data has shown substantial agreement with a previous retrospective observational cohort study.[25] These findings revealed that special attention should be given after any fragility fracture in postmenopausal women to reduce the risk of subsequent fractures.

Our study has a positive association between parenteral HF and MOF; this is supported by cohort studies as well as a survey by Yang *et al*.[26] conducted in Canada. This study showed that patients treated with glucocorticoids have a significantly higher risk of osteoporotic fracture. Thus, a prescription should be given to them to prevent future fractures, not only with calcium supplements and vitamin D but also with antiresorptive therapy, which can be discontinued after cessation of glucocorticoids if there are no other risk factors. A similar study indicated that premenopausal women with a history of fractures or receiving a high dose of glucocorticoids should use bone protective agents.[27] For example, the IOF-European Calcified Tissue Society framework recommends that the FRAX score be used to decide the lifelong bone protective agents used for postmenopausal women and men aged 50 years or older who are on oral glucocorticoids for at least 3 months.[28]

Our study reported a significant association between RA and HF and MOF. Inflammation leads to bone loss near the affected joint. Several studies have also demonstrated bone loss in areas distant from the affected joint. This could be explained by the systemic effects of the disease, reduced mobility, nutritional deficiencies, and weight loss.[29]

The study examined the effect of IDDM on bone quality, and it was found that this disease is significantly associated with weak bones. This may be due to increased calcium loss in the urine and negative calcium balance when the blood glucose level is high. In addition, in diabetes, there is resistance to the parathyroid hormone, leading to low calcium levels and increased fracture risk. Moreover, the glycosylation of collagen and its end products alters the bone structure.[30] Prior studies correlated the complications of IDDM and increased fracture risk. These complications include retinopathy, neuropathy, kidney disease, and cardiovascular diseases.[31]

Table 3: Correlation between participants' variables and hip fractures/major osteoporotic fractures.

Variable		Hip fracture		Total	P-value	Major osteoporotic fracture			Total	P-value
		< 3%	> 3%			< 10%	10-19%	> 20%		
Age										
40-50	N(%)	117 (99.2)	1 (0.8)	118 (100)	0.000	117 (99.2)	0 (0.0)	1 (0.8)	118 (100)	0.000
51-60	N(%)	121 (95.3)	6 (4.7)	127 (100)		111 (87.4)	14 (11.0)	2 (1.6)	127 (100)	
61-70	N(%)	54 (68.4)	25 (31.6)	79 (100)		33 (41.8)	40 (50.6)	6 (7.6)	79 (100)	
71-80	N(%)	0 (0.0)	16 (100)	16 (100)		0 (0.0)	9 (56.3)	7 (43.8)	16 (100)	
81-90	N(%)	1 (10.0)	9 (90)	10 (100)		0 (0.0)	2 (20.0)	8 (80.0)	10 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.86)	350 (100)	
Body mass index										
< 18	N(%)	12 (70.6)	5 (29.4)	17 (100)	0.001	12 (70.6)	1 (5.9)	4 (23.5)	17 (100)	0.000
18-25	N(%)	89 (75.4)	29 (24.6)	118 (100)		75 (36.6)	37 (31.4)	6 (5.1)	118 (100)	
> 25	N(%)	192 (89.3)	23 (10.7)	215 (100)		174 (80.9)	27 (12.6)	14 (6.5)	215 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	
Previous fragility fracture										
Yes	N(%)	15 (62.5)	9 (37.5)	24 (100)	0.004	9 (37.5)	8 (33.3)	7 (29.2)	24 (100)	0.000
No	N(%)	278 (85.3)	48 (14.7)	326 (100)		252 (77.3)	57 (17.5)	17 (5.2)	326 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	
Parent hip fracture										
Yes	N(%)	17 (77.3)	5 (22.7)	22 (100)	0.398	11 (50.0)	7 (31.8)	4 (18.2)	22 (100)	0.014
No	N(%)	276 (84.1)	52 (15.9)	328 (100)		250 (76.2)	58 (17.7)	20 (6.1)	328 (100)	
Total	N(%)	284 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	
Oral glucocorticoids										
Yes	N(%)	22 (55)	18 (45)	40 (100)	0.000	16 (40)	13 (32.5)	11 (27.5)	40 (100)	0.000
No	N(%)	271 (87.4)	39 (12.6)	310 (100)		245 (79.0)	52 (16.8)	13 (4.2)	310 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	
Diagnosed rheumatoid arthritis										
Yes	N(%)	29 (54.7)	24 (45.3)	53 (100)	0.000	24 (45.3)	17 (32.1)	12 (22.6)	53 (100)	0.000
No	N(%)	264 (88.9)	33 (11.1)	297 (100)		237 (79.8)	48 (16.2)	12 (4.0)	297 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	
Insulin-dependent diabetes										
Yes	N(%)	11 (52.4)	10 (47.6)	21 (100)	0.000	11 (52.4)	8 (38.1)	2 (9.5)	21 (100)	0.043
No	N(%)	282 (85.7)	47 (14.3)	329 (100)		250 (76.0)	57 (17.3)	22 (6.7)	329 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	
Premature menopause										
Yes	N(%)	65 (91.5)	6 (8.5)	71 (100.0)	0.045	62 (87.3)	6 (8.5)	3 (4.2)	71 (100)	0.021
No	N(%)	228 (81.7)	51 (18.3)	279 (100.0)		199 (71.3)	59 (21.1)	21 (7.5)	279 (100)	
Total	N(%)	293 (83.7)	57 (16.3)	350 (100)		261 (74.6)	65 (18.6)	24 (6.9)	350 (100)	

P-value < 0.05 is considered statistically significant

We also found a significant correlation between malabsorption (which causes low calcium absorption) and an increased risk of fracture, particularly HF. It is well known that osteomalacia, which is due to vitamin D depletion, is a leading cause of the decrease in BMD.[32] Our results show a weak correlation between chronic malnutrition, CLD, and osteogenesis imperfecta. A possible reason for this is the small sample size in comparison to cohort studies.

Our study has limitations, as it is a cross-sectional observational study. Therefore, a cohort study with a larger sample size is needed. In addition, this study had few participants, which masks the relationships between some factors and fragility fractures. Furthermore, there is a lack of detail on some risk factors, for example, the duration of oral glucocorticoids, the smoking dose, and how many previous fractures. Moreover, the FRAX tool did not contain all risks of falls and must not replace clinical judgment.

CONCLUSION

According to the FRAX tool, 16.3% and approximately 7% of our participants have a risk for HF and MOF, respectively. In addition, our study identified multiple risk factors significantly correlated with osteoporotic fractures. These factors include low body weight, previous fragility fractures, parent HF, glucocorticoid use, IDDM, and premature

menopause. Therefore, we conclude that the FRAX tool is useful in predicting 10-year fracture risk.

AUTHORS' CONTRIBUTIONS

SKN: Concepts, design, data analysis, manuscript editing and review. MSM: Literature search, data acquisition, data analysis, manuscript preparation, manuscript editing and review. AMF: Manuscript preparation, manuscript editing and review. SIF: Manuscript editing and review. FBM: Manuscript editing and review. SOB: Manuscript editing and review. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ACKNOWLEDGMENT

We thank the medical students of the faculty of medicine at the Nile Valley University for their outstanding effort in participating in data collection from study participants.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The authors confirm that there was no use of Artificial Intelligence (AI)-Assisted Technology for assisting in the writing or editing of the manuscript and no images were manipulated using the AI.

ETHICAL APPROVAL

The study proposal was presented to the Sudanese Medical Specialization Board ethical committee for ethical clearance, which was done on December 2, 2019, serial number; SMS 10.2019.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patients consent forms. In the form, the patients have given their consent for their clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

FINANCIAL SUPPORT AND SPONSORSHIP

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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