Cross-Sectional Study

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FRAX calculation with and without bone mineral density for assessment of osteoporotic fracture risk in patients of rheumatic disease: a cross-sectional study

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Aim: To compare fracture risk assessment (FRAX) calculation with and without bone mineral density (BMD) in predicting 10-year probability of hip and major osteoporotic fracture in patients of rheumatic diseases.

Methodology: A cross-sectional was conducted at outpatient Department of Rheumatology. Eighty-one Patients of more than 40 years of age having either sex. Diagnosed case of Rheumatic diseases were according to American College of Rheumatology (ACR) /European Alliance of Associations for Rheumatology (EULAR) criteria were included in our study. FRAX score without BMD was calculated and information was recorded in proforma. These patients were advised dual energy X-ray absorptiometry Scan and after that FRAX with BMD was calculated, after which comparison between result of two scores was made. The data were analyzed by SPSS software version 24. Effect modifiers were controlled by stratification. Post-stratification χ^2 test were applied. *P* value less than 0.05 was considered as significant

Results: This study consisted of 63 participants, who were assessed for osteoporotic risk fracture, with and without BMD. Data analysis revealed a significant association between the type of fracture and age (*p* value = 0.009), previous fracture (*p* value = 0.25), parent fractured hip (*p* values) and treatment with bone mineral dismissal. There was no statistically significant association seen of fractures with bone deterioration with sex, weight, height, or current smoking.

Conclusion: FRAX may be crucial in rural areas where dual energy X-ray absorptiometry scanning is not available since it is a readily available instrument. FRAX is a useful substitute for estimating osteoporosis risk when funds are scarce. Given the possible effect it will have on healthcare costs, this is extremely pertinent.

Keywords: FRAX, osteoporosis, public health, rheumatic disease

Introduction

Osteoporosis is a systemic skeletal condition characterized by increased bone fragility as a result of decreased bone mineral density (BMD) or loss of bone trabecular microarchitecture. Osteoporosis prevalence rises with age, regardless of sex; however it is more common in postmenopausal women[1]. In the USA, 1 in 4 women and 1 in 20 men over 65 have osteoporosis, which is typically clinically asymptomatic until a fragility fracture occurs. Therefore, it is crucial to diagnose patients quickly and begin therapy before a fragility fracture develops[2]. For the evaluation of the risk of osteoporotic fracture, many scoring systems are recommended, namely osteoporotic risk assessment instrument, WHO BMD and Fracture risk assessment tool (FRAX).

The WHO's Collaborating Center for Metabolic Bone Disease created the FRAX score algorithm, which was initially made public in 2008. An algorithm is designed for use in primary care to estimate the likelihood of fracture in men and women based on early-accessible clinical risk variables. The outcomes of FRAX show a 10-year risk of hip fracture and a 10-year likelihood of

HIGHLIGHTS

- This cross-sectional study has shown that fracture risk assessment may be crucial in rural areas where dual energy X-ray absorptiometry scanning is not available since it is a readily available instrument.
- Fracture risk assessment is a useful substitute for estimating osteoporosis risk when funds are scarce.
- Given the possible effect it will have on healthcare costs, this is extremely pertinent.

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severe osteoporotic fractures (including the clinical spine, humerus, wrist, and hip). Over 1 million patient years in 11 separate cohorts with identical geographic distribution have enabled the FRAX algorithm to be validated. Following risk factors are used in FRAX calculation: age, sex, weight (kg), height (cm), history of previous fractures(yes or no), parental history of fractures (yes or no), current smoker (yes or no), oral glucocorticoid exposure currently or for more than 3 months, rheumatoid arthritis (yes or no), secondary osteoporosis or disorder strongly associated with osteoporosis including type 1 diabetes mellitus, Osteogenesis imperfect in adult, untreated long standing hyperthyroidism, hypogonadism, premature menopause, chronic malabsorption, CLD, 3 or more units of alcohol daily (yes or no), BMD (optional input to fracture risk prediction)[3].

In order to ascertain whether using FRAX without BMD was as effective as using FRAX with BMD in predicting the risk of osteoporotic fracture and recommending treatment for male veteran patients, Rachel and colleagues conducted a retrospective study in Lexington Veterans Affair Medical Center (Kentucky state of the USA). The findings of this study showed that for 82.4% (98 out of 119 patients) of male veteran patients, FRAX calculation without BMD offered the same therapy recommendations as FRAX calculation with BMD. The remaining 17.6% (21 patients) were given a different course of therapy. Older age, higher BMD, and higher T Score were all indicators of the same treatment prescription. In light of the foregoing, it may be concluded that the FRAX score, in addition to BMD, is helpful in identifying fracture risk and prescribing appropriate care for male patients older than 65[4].

In a retrospective research, Sang Tae and colleagues evaluated FRAX criteria with and without BMD and WHO BMD criteria in order to assess the prevalence and fracture risk of osteoporosis in patients with rheumatoid arthritis. Between January 2012 and December 2016, this retrospective cross-sectional study, which involved 479 patients with rheumatoid arthritis at five hospitals, was carried out. Health Industry Development Institute Korea carried out this investigation. FRAX criteria were computed with and without BMD. In 81 individuals (16.9%), osteoporotic fractures were found. There were 292 (61%) candidates who needed pharmaceutical intervention using FRAX without BMD, 226 (47.2%) using BMD, and 160 (33.4%) using WHO BMD standards[5].

Rationale

This study will be first of its type in our population that will compare the result of FRAX score with and without BMD for assessment of osteoporotic fracture risk in patients of rheumatic diseases. We can use FRAX without BMD in cases of limited finances and rural settings where dual energy X-ray absorptiometry (DEXA) scan is not available for prediction of osteoporotic fracture risk in patients of rheumatic disease.

Objectives

To compare FRAX calculation with and without BMD in predicting 10-years probability of hip and major osteoporotic fracture in patients of rheumatic diseases.

Materials and methods

A cross-sectional was conducted at outpatient department of Rheumatology. The study was completed within 3 months of approval by Ethics Research Review Board. Sample size was calculated by using WHO sample size calculator where confidence level was 95%, absolute precision was 8% and population proportion was 84%. The sample size was 81 patients. Non-probability consecutive sampling technique was applied.

Patients were more than 40 years of age having either sex. Diagnosed case of rheumatic diseases were according to American College of Rheumatology (ACR) /European Alliance of Associations for Rheumatology (EULAR) criteria. All patients who were diagnosed with osteoporosis or treated with FDA-approved agent for osteoporosis and all those patients who were pregnant were excluded.

All patients fulfilling the inclusion criteria were enroled for study. The importance and purpose of the study was explained to the participants After receiving patients as per inclusion criteria, complete history was taken from them. Thorough and complete examination was performed. FRAX score without BMD was calculated and information was recorded in proforma. These patients were advised DEXA Scan and after that FRAX with BMD was calculated, after which comparison between result of two scores was made.

The data was analyzed by SPSS software version 24. Descriptive statistics were calculated for all variables like age, sex, weight (kg), height (cm), history of previous fractures (yes or no). parental history of fractures(yes or no), current smoker (yes or no), oral glucocorticoid exposure currently or for more than 3 months, rheumatoid arthritis (yes or no),secondary osteoporosis . Frequency and percentage were presented for qualitative variables. Mean and SD were calculated for all quantitative variables. Effect modifiers were controlled by stratification. Post-stratification χ^2test were applied. P value less than 0.05 was considered as significant.

Results

This consisted of 63 participants, who were assessed for osteoporotic risk fracture, with and without BMD. There was a significant association between osteoporotic risk fracture with BMD and age (p value = 0.009), previous fracture (p value = 0.009), hip fracture with BMD (p value = 0), treatment with BMD (p value = 0.007) and treatment without BMD (p value = 0.001). There was no statistically significant association seen of osteoporotic risk fracture with BMD with sex (p value = 0.79), weight (p value = 0.56) , height (p value = 0.82), parent fractured hip (p value = 0.6), current smoking (p value = 0.56), glucocorticoids (p value = 0.97), rheumatoid arthritis (p value = 0.91), secondary osteoporosis (p value = 0.55), alcohol (p value = 0.69), femoral neck with BMD (p value = 0.24), hip fracture without BMD (p value = 0.74), and rheumatic disease (p value = 0.58). [Table 1].

Regression analysis was performed to observe the association of osteoporotic risk fracture with and without BMD with the independent variables. The overall regression analysis for osteoporotic fracture risk with BMD was statistically significant (R^2 = 0.70, F = 6.66, P = 0), as shown in Figure 1.

Table 1

Correlation of risk factors for osteoporotic fracture with bone mineral density vs without bone mineral density and odds ratio ($n = 63$)

Factors affecting osteoporotic fracture risk	Osteoporotic fracture risk (with BMD) ($n = 63$), n (%)				Osteoporotic fracture risk (without BMD) ($n = 63$) , n (%)			
	1–31	32–62	*P*	OR, CI [range]	1–18	19–36	*P*	OR, CI [range]
Age								
40–60	43 (71.7)	0	0.009	0.283,95% [0.18–0.42]	42 (77.8)	1 (11.1)	0	28, 95% [3.17–246.6]
61–82	17 (28.3)	3 (100)			12 (22.2)	8 (88.9)		
Sex								
Male	4 (6.7)	0			4 (7.4)	0	0.466	
Female	52 (86.7)	3 (100)	0.795		46 (85.2)	9 (100)		
Weight (kg)								
35–90	54 (90)	3 (100)	0.565	0.9, 95% [0.82–0.97]	48 (88.9)	9 (100)	0.293	0.88, 95% [0.8–0.97]
91–148	6 (10)	0			6 (11.1)	0		
Height (cm)								
87–120	1 (1.7)	0	0.822	0.98, 95% [0.95–1.01]	1 (1.9)	0	0.681	0.98,95% [0.94–1.01]
121–170	59 (98.3)	3 (100)			53 (98)	9 (100)		
Previous fracture								
Yes	1 (1.7)	1 (33.3)	0.009		1 (1.9)	1 (11.1)	0.252	
No	55 (91.7)	2 (66.7)			49 (90.7)	8 (88.9)		
Parent fractured hip								
Yes	0	0	0.602	0.91, 95% [0.84–0.98]	0	0	0.341	0.9, 95% [0.83–0.98]
No	55 (91.7)	3 (100)			49 (90.7)	9 (100)		
Current smoking								
Yes	0	0	0.565	0.9, 95%, [0.82–0.97]	0	0	0.293	0.88,95% [0.8–0.97]
No	54 (90)	3 (100)			48 (88.9)	9 (100)		
Glucocorticoids								
Yes	41 (68.3)	2 (66.7)	0.970		37 (68.5)	6 (66.7)	0.902	
No	18 (30)	1 (33.3)			16 (29.6)	3 (33.3)		
Rheumatoid arthritis								
Yes	33 (55)	2 (66.7)	0.911		29 (53.7)	6 (66.7)	0.733	
No	26 (43.3)	1 (33.3)			24 (44.4)	3 (33.3)		
Secondary osteoporosis								
Yes	15 (25)	0	0.559		12 (22.2)	3 (33.3)	0.673	
No	43 (71.7)	3 (100)			40 (74.1)	6 (66.7)		
Alcohol								
Yes	0	0	0.691	0.95, 95%, [0.89–1]	0	0	0.469	0.94, 95% [0.88–1]
No	57 (95)	3 (100)			51 (94.4)	9 (100)		
Femoral neck (BMD)								
0–5	41 (68.3)	3 (100)	0.243	0.68, 95%, [0.57–0.81]	37 (68.5)	7 (77.8)	0.575	0.62, 95% [0.6–3.3]
0–11	19 (31.7)	0			17 (31.5)	2 (22.2)		
Hip fracture (without BMD)								
0–10	58 (96.7)	3 (100%)	0.748		54 (100)	7 (77.8)	0	
11–20	2 (3.3)	0			0	2 (22.2)		
Hip fracture (BMD)								
0–23	60 (100)	1 (33.3)	0	3,95%, [0.6–14.86]	53 (98.1)	8(88.9)	0.142	6.6, 95% [0.3–116.8]
24–47	0	2 (66.7)			1 (1.9)	1 (1.11)		
Treatment (BMD)								
Yes	16 (26.7)	3 (100)	0.007	0.26, 95%, [0.17–0.4]	12 (22.2)	7 (77.8)	0.001	0.08, 95% [0.01–0.44]
No	44 (73.3)	0			42 (77.8)	2 (22.2)		
Treatment (without BMD)								
Yes	10 (16.7)	3 (100)	0.001	0.16, 95%, [0.09–0.29]	5 (9.3)	8 (88.9)	0	0.01, 95% [0–0.12]
No	50 (83.3)	0			49 (90.7)	1 (11.1)		
Rheumatic disease								
Rheumatoid arthritis	33 (55)	2 (66.7)		29 (53.7)		6 (66.7)		
Psoriatic arthritis	1 (1.71)	0				0		
HCV-associated arthropathy	1 (1.71)	0		1 (1.9)		0		
Ankylosis spondylitis	1(1.71)	0		1 (1.9)		0		
Osteoarthritis	9 (15)	0		1 (1.9)		0		
Systemic lupus erythematous	4 (6.7)	0		9 (16.7)		1 (11.1)		
Chronic backache/ lumbar spondylosis	1 (1.71)	1 (33.3)	0.581	3 (5.6)		1 (11.1)	0.43	
Osteomalacia	1 (1.71)	0		1 (1.9)		0		
Gout	1 (1.71)	0		1 (1.9)		1 (11.1)		
Axial spA	1 (1.71)	0		0		0		

Table 1

(*Continued*)

Factors affecting osteoporotic fracture risk	Osteoporotic fracture risk (with BMD) ($n=63$), n (%) 1–31	32–62	*P*	OR, CI [range]	Osteoporotic fracture risk (without BMD) ($n=63$) , n (%) 1–18	19–36	*P*	OR, CI [range]
Cervical spondylitis	3 (5)	0		1 (1.95)3 (5.6)	0			
Cervical spondylosis	2 (3.3)	0		2 (3.7)	0			

BMD, bone mineral density; HCV, hepatitis C virus; OR, odds ratio.

Moreover, the overall regression analysis for osteoporotic fracture risk BMD was also statistically significant ($R^2 = 0.61$, $F=4.39$, $P = 0$), as shown in Figure 2.

Discussion

As rheumatic disorders are conditions of chronic inflammation known to promote an increase in osteoclastic different ions and limit osteogenesis, osteoporosis is a well-known complication in individuals with these illnesses. Additionally, glucocorticoid therapy exacerbates the imbalance that previously exists as a result of the illness. Therefore, rheumatic disorders have a higher frequency of osteoporosis than in the general population, making it crucial to estimate the risk of osteoporotic fractures in this population[6].

It is advised that patients with osteopenia utilize the FRAX tool to determine which of them are most at risk of developing an

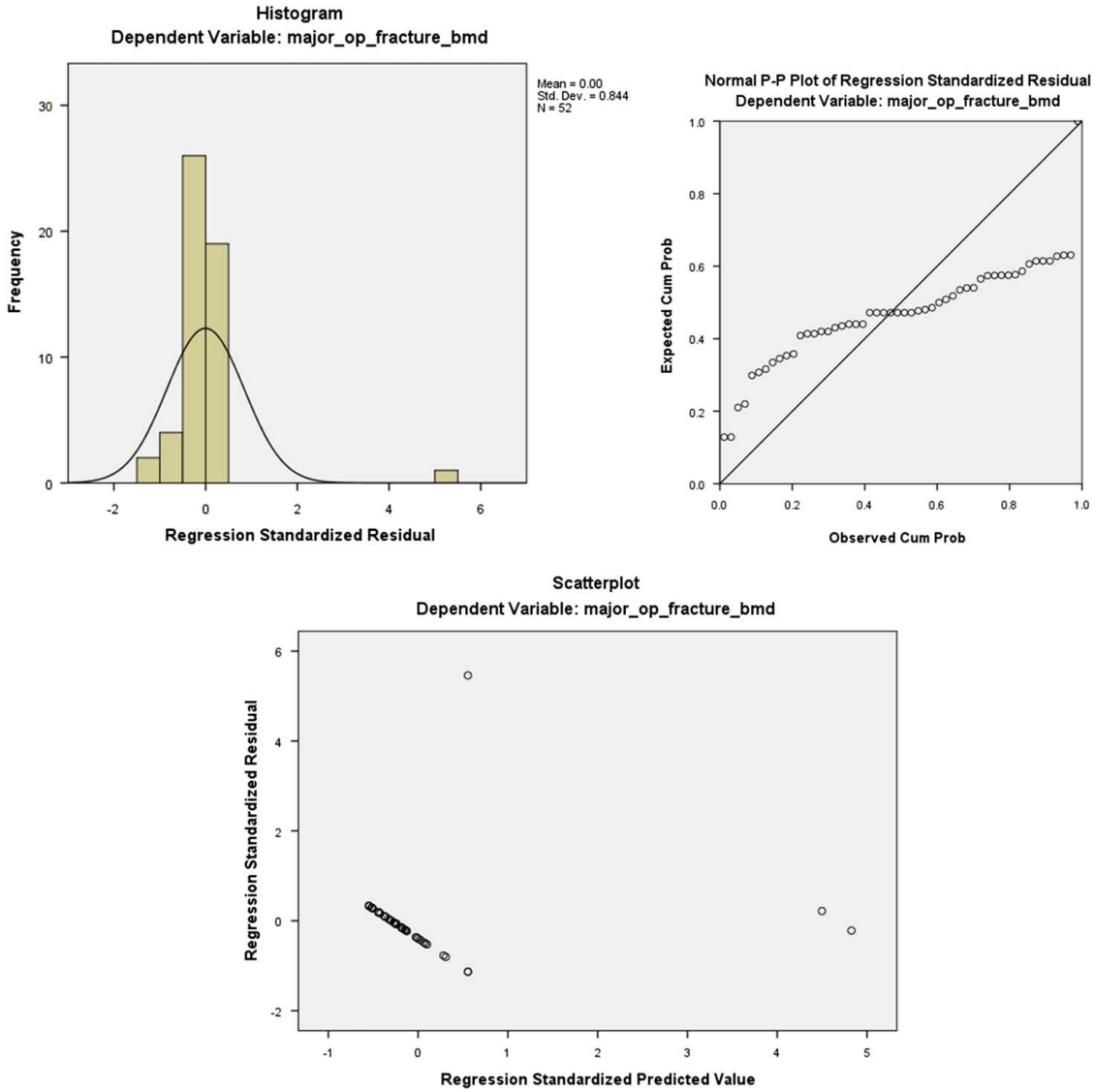

Figure 1. Association of osteoporotic risk fracture with and without bone mineral density.

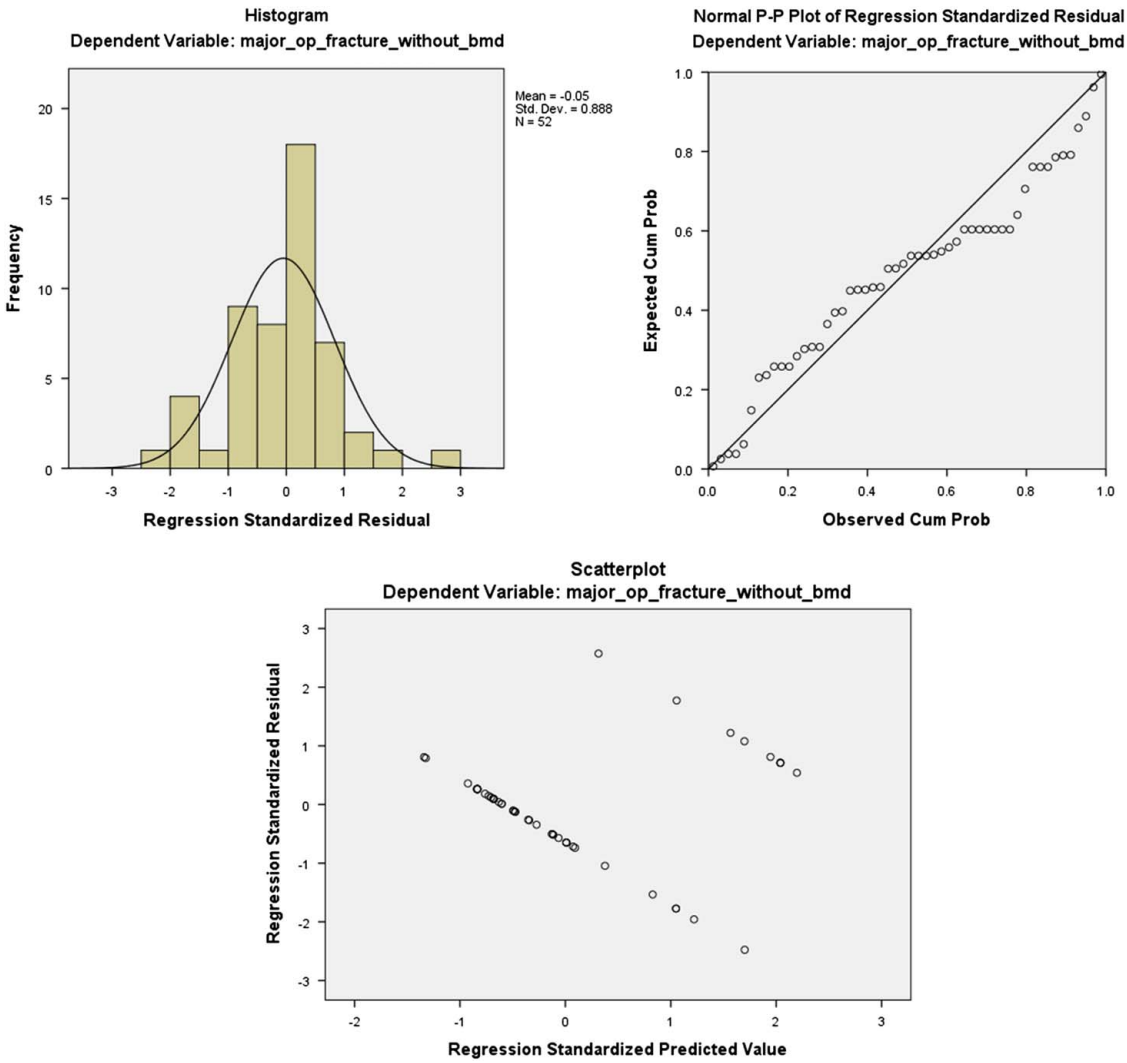

Figure 2. Regression analysis for osteoporotic fracture risk.

osteoporotic fracture and treat them with medications that have received FDA approval[7]. According to current recommendations, a DXA scan should be performed on postmenopausal women over 65 and younger postmenopausal women who have risk factors for osteoporosis[8]. In individuals with osteopenia, therapy with FRAX is advised if the 10-year risk is less than 20% for major osteoporotic fracture and/or less than 3% for hip fractures[9]. It was crucial to establish if FRAX alone is a reliable fracture prediction tool because BMD data might not always be accessible.

In this study, we discuss the results of FRAX score with and without BMD for assessment of osteoporotic fracture risk in patients of rheumatic diseases. The study investigated the association between osteoporotic risk fracture and BMD among 63 participants. The results showed a significant association between osteoporotic risk fracture with BMD and age, previous fracture, hip fracture with BMD, treatment with and without BMD. However, there was no statistically significant association with sex, weight, height, parent fractured hip, current smoking, glucocorticoids, rheumatoid arthritis, secondary osteoporosis, alcohol, femoral neck with BMD, hip fracture without BMD, and rheumatic disease. Odds ratio was calculated to determine the risk of osteoporotic fracture, and the analysis showed no significant association with most of the factors studied, except hip fracture with BMD, and treatment with and without BMD. Regression analysis was also performed, and the overall regression analysis for osteoporotic fracture risk with and without BMD was statistically significant.

Individuals in the 61–82 age group with BMD have a lower odd of experiencing an osteoporotic fracture compared to individuals in the 40–60 age group. This also means that younger age is more indicative of an identical forecast. However, it's important to note that the sample size for the 61–82 age group is only 17, which is relatively small. Additionally, the *p* value for the age variable is 0.009, which indicates a statistically significant difference in fracture risk between the two age groups. Conversely, the odds ratio for osteoporotic fracture risk without BMD in individuals aged 61–82 years is 28, with a 95% CI range of 3.17–246.6. This means that individuals aged 61–82 years have

28 times higher odds of osteoporotic fracture compared to those aged 40–60 years.

There is a significant difference in Osteoporotic fracture risk with BMD between those with a previous fracture and those without. Among the study population ($n = 63$), only one person with no previous fracture had an osteoporotic fracture, while two out of three people (66.7%) with a previous fracture had an osteoporotic fracture. Alternatively, there was no significant difference in the prevalence of previous fractures in osteoporotic fracture risk without BMD. ($P = 0.252$).

In osteoporotic fracture risk without BMD, a p value of 0 for hip fracture without BMD suggests that the association between the risk factors included in the FRAX tool and the occurrence of hip fracture without BMD is statistically significant. This means that the FRAX tool is effective in predicting hip fracture risk even without measuring BMD. Conversely, in osteoporotic fracture risk with BMD, a p value of 0 for hip fracture with BMD suggests that the presence of BMD has a significant effect on the risk of hip fracture. Specifically, it suggests that there is a strong association between low BMD and increased risk of hip fracture.

For osteoporosis fracture risk with BMD, there were two groups, those who received treatment with BMD and those who did not receive treatment with BMD. The p value for the treatment effect is 0.007, which means that there is a statistically significant difference in the osteoporotic fracture risk between those who received treatment and those who did not. Therefore, the treatment with BMD appears to significantly reduce the risk of osteoporotic fractures. The odds ratio for osteoporotic fracture risk without BMD in patients who received treatment (BMD) is 0.08 (95% CI: 0.01–0.44) compared to those who did not receive treatment. The p value for this comparison is 0.001. This suggests that there is a statistically significant difference in osteoporotic fracture risk between the two groups and that receiving BMD treatment may lower the risk of fracture.

For osteoporosis fracture risk with BMD, there were two groups, those who received treatment without BMD and those who did not receive treatment without BMD. The p value for the treatment effect is 0.001, which means that there is a statistically significant difference between receiving treatment without BMD and reduced risk of osteoporotic fracture with BMD. Therefore, the treatment without BMD appears to significantly reduce the risk of osteoporotic fractures. The odds ratio of 0.16 suggests that participants who received treatment without BMD had 84% lower odds of experiencing an osteoporotic fracture compared with those who did not receive treatment without BMD. The risk of osteoporotic fracture without BMD is significantly lower in individuals who received treatment without BMD compared to those who did not receive treatment [p value = 0.01, odds ratio = 0.01, 95% confidence interval (0–0.12)]. Specifically, the odds of osteoporotic fracture in individuals who received treatment without BMD are approximately 100 times lower than the odds of osteoporotic fracture in individuals who did not receive treatment without BMD.

In addition to calculating the fracture probability offset by predicted mortality, FRAX employs more intricate calculations that take into consideration the interplay of risk factors with age. As people age, the FRAX mortality offset becomes more significant, significantly lowering estimates of fracture risk seen in individuals over 75. There is a substantial correlation between hip fracture and osteoporotic fracture risk, both with and without BMD. FRAX estimates 10-year probability of a hip fracture and any one of the four main osteoporotic fractures (clinical spine, wrist, proximal humerus, and hip)[10]. Our study, which overcame the conventional constraint of excluding participants with prior fractures, identified a relationship between prior fractures and osteoporotic risk fracture.

There are several treatments and lifestyle modifications that can help reduce the risk of fractures associated with osteoporosis. Here are some examples:

(1) Calcium and vitamin D supplementation: Calcium and vitamin D are essential for building and maintaining strong bones. Adequate calcium and vitamin D intake can reduce the risk of fractures. Calcium-rich foods include dairy products, leafy greens, and fortified foods. Vitamin D can be obtained through sun exposure, fortified foods, and supplements.
(2) Medications that increase bone density: Several medications are available that can increase bone density and reduce the risk of fractures. These include bisphosphonates, denosumab, teriparatide, and others. These medications work by slowing down bone loss or by increasing bone formation.
(3) Regular weight-bearing exercise: Weight-bearing exercises, such as walking, running, and weightlifting, can help strengthen bones and reduce the risk of fractures. Exercise can also improve balance and coordination, which can reduce the risk of falls.
(4) Fall prevention strategies: Preventing falls is an important part of reducing the risk of fractures. Strategies include wearing appropriate footwear, removing tripping hazards, installing grab bars and handrails, and using assistive devices, such as canes or walkers, if needed.
(5) Avoiding smoking and excessive alcohol consumption: Smoking and excessive alcohol consumption can increase the risk of fractures. Quitting smoking and limiting alcohol intake can help reduce the risk of fractures.

Younger age is more suggestive of an identical forecast. Therefore, if you have limited funds and you live in a remote area without access to DEXA scans. FRAX without BMD is a viable substitute for predicting osteoporotic loss[11].

Conclusion

In our investigation, FRAX yielded predictions that were almost identical to FRAX/BMD forecasts in most situations. A similar forecast is more suggestive of younger age. As a result, FRAX is a useful screening technique for determining the likelihood of an osteoporotic fracture. Given the possible effect it will have on healthcare expenses, this is extremely pertinent. FRAX may be crucial in rural areas where DEXA scanning is not available since it is a readily available instrument. FRAX is a useful substitute for estimating osteoporosis risk when funds are scarce.

Ethical approval

Obtained from PIMS.

Consent

Approved from all the authors for final submission and obtained by the participants for using their data consenting for publication.

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Author contribution

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Conflicts of interest disclosure

No conflict of interest declared.

Research registration unique identifying number (UIN)

1. Name of the registry: Research registry.
2. Unique Identifying number or registration ID: research-registry8353.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/browse-theregistry#home/registrationdetails/63315e12df7d4000224ee100/

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