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# Exploring fracture risk assessment tool (FRAX®) for women 50 years and older: A cross-sectional study

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**ABSTRACT**

The fracture risk assessment tool (FRAX®) is useful in clinical practice for assessing ten-year major osteoporotic and hip fracture risk. This cross-sectional study aimed at assessing possible predictors of the FRAX® score for Jordanian women. Univariate and multivariate linear regression analysis was used to evaluate predictors of the FRAX® score. A total of 400 women were included in the study, hypertension was the most common medical condition, 66.3% ($n$ = 265) of the participants did not have their vitamin D status checked, 9.0% of the respondents had insufficiency ($n$ = 36), while 7.5% had deficiency ($n$ = 30). Higher age at menopause and longer duration since menopause were predictors of higher scores for major osteoporotic fractures and hip fractures, with both p-values < 0.001. Using the FRAX® score for early identification of women with high risk, especially those with longer years of menopause provides an opportunity of early preventive measures.

**Keywords:** assessment, bone fracture, risk, osteoporosis, cross-sectional study

## INTRODUCTION

Osteoporosis is described as a hidden skeletal illness marked by decreased bone strength that elevates the chance of fracture, particularly in low-impact trauma. It is a significant health concern linked to aging that puts both men and women at risk for fractures and subsequent complications [1]. The financial, medical, and social burdens of the Middle East and Africa will increase significantly as the population ages [2]. Indeed, death rates following a hip fracture may be higher in this region than in the West, where rates range from 25 to 30%. They are 2-3 times higher in the Middle East and Africa [3].

The fracture risk assessment tool (FRAX®) is a useful tool in clinical practice among the instruments available for assessing fracture risk. It was first created in 2008 by the University of Sheffield's World Health Organization (WHO) Collaboration Center in the United Kingdom. FRAX® is a tool that estimates the 10-year chance of significant osteoporotic and hip fractures by combining measurements of bone mineral density (BMD) with clinical risk factors [4]. FRAX® offers a thorough assessment of fracture risk by considering variables like age, sex, weight, height, prior fracture history, parental hip fracture, smoking status, alcohol intake, glucocorticoid use, rheumatoid arthritis, and secondary osteoporosis. FRAX® is available as a Web-based algorithm (www.shef.ac.uk/FRAX) that estimates the 10-year risk of major osteoporosis-related fractures and hip fractures in men and women using easily accessible clinical risk variables and BMD [5]. In February 2008, the National Osteoporosis Foundation updated its US guidelines to include FRAX® [6]. The recommendations state that drug therapy should be considered for all postmenopausal women and men aged 50 and older who have experienced a hip or vertebral fracture, have a t-score of ≤ -2.5 at the femoral neck or spine (excluding secondary causes), or have low bone mass (t-score between -1.0 and -2.5) and a 10-year probability of hip fracture ≥ 3% or of major osteoporosis-related fracture ≥ 20% (based on FRAX®) [7]. Although FRAX® has been shown to be clinically useful, it has limitations and shouldn't be applied in every circumstance. The identification of men and women who are more susceptible to osteoporotic fractures may be aided by the acceptance and clinical application of FRAX®; yet busy doctors may find it difficult to integrate the instrument into their daily practices [8].

According to a recent meta-analysis, 18.3% of people worldwide are estimated to have osteoporosis. The global prevalence of osteoporosis in women was found to be 23.1%, whilst the global prevalence in men was found to be 11.7% [9]. In Jordan, 19.8% of postmenopausal women had osteoporosis [10].

A hospital-based convenient sample study was conducted in Egypt and enrolled patients referred to the outpatient

radiology department for dual-energy X-ray absorptiometry (DEXA) scans. The likelihood of fracture was computed using nine FRAX® calculators (Abu Dhabi, Iran, Jordan, Kuwait, Lebanon, Tunisia, Palestine, Syria, Morocco, and the United Arab Emirates). This was done with and without the use of BMD. The results from this study have shown that there was a lot of agreement between the predicted risk and treatment recommendations using the FRAX® method, whether or not BMD was included [11].

The aim of this study was to identify the fracture risk among women 50 years and older, using FRAX® score and examine possible socioeconomic and clinical predictors of the fracture assessment score. This will shed light on women who are at greater risk and can be offered early preventive management and reduce the future burden on the patients and on an overwhelmed healthcare system.

## MATERIALS AND METHODS

This was a cross-sectional study conducted in the woman's health, maternity, and childhood department and family medicine department in Ain Al Basha comprehensive health centre, Ministry of Health, Amman, Jordan. Ethical approval was obtained from the Ministry of Health Ethical Committee, Amman, Jordan, number MOH/REC/2022/137. The study started in November 2022 and continued until October 2023. Family physicians and a researcher assistant collected the data from the participants. A convenient sampling method was used where women 50 years and older attending the clinics were approached. The aim of the study and, type of information needed, and the use of anonymous data for publication of the study were explained to the candidates, written informed consents were signed by the women who agreed to participate. Data was collected using data collection form, that included demographics, clinical information, and risk factors for the FRAX® fracture. The WHO FRAX® for Jordan was used to calculate the risk for major and hip fracture probability in 10 years' time. Risk factors included history of prior fracture, family history of parental fracture, current smoking, long term glucocorticoids use, rheumatoid arthritis, secondary osteoporosis and alcohol consumption. The FRAX® score was calculated without the DEXA. Inclusion criteria: women 50 years or above. Exclusion criteria: women diagnosed with osteoporosis or receiving drugs for osteoporosis.

Height (kg) and weight ($m^2$) were recorded based on the patients most recent information to calculate body mass index (BMI). Participants with BMI ≥ 30 were considered obese. A current smoker is a person who smokes cigarettes daily or occasionally.

Good sun exposure was defined as exposure of the hands, face, and arms to the sun daily for 10-15 minutes per day. Moderate exposure 5-10 minutes, and minimal exposure is less than 5 minutes. High caffeine intake (> 300 mg/day) is equivalent to 3 cups of coffee. Vitamin D status was classified as follows: vitamin D deficiency (< 20 ng/mL), vitamin D insufficiency (20-29 ng/mL), and normal vitamin D (≥ 30 ng/mL). Menopause is defined as no period for one year. Duration of menopause was calculated by subtracting age at menopause from current age at enrolment.

### Sample Size Calculation

$$n = \frac{[Z \times Z \times P(1-P)]}{d \times d}, \quad (1)$$

where $n$ is the sample size, $Z$ is the statistic corresponding to level of confidence $Z$ for a 95% confidence interval is 1.96, $P$ is expected prevalence (results from similar studies, 50% provides the largest sample size), 1-$P$ = 50%, $d$ is precision (corresponding to effect size = 0.05) [12]. $N$ = 238 is the minimum required sample size. A larger number of participants were targeted for better representation. The total number was 400.

### Statistical Analysis

Data were entered to IBM SPSS statistics version 22.0 for analysis. Categorical variables were analyzed using frequencies and percentages, while continuous variables were assessed using median and inter-quartile range (IQR). To evaluate predictors affecting women's ten-year major osteoporotic score and ten-year hip fracture score, both univariate and multivariable linear regression analyses were employed. Variables with significance at a single predictor level ($p < 0.25$) from the univariate logistic regression analysis were included in the multiple logistic regression analyses. The independence of variables was verified using Pearson correlation, where an $r < 0.9$ indicates no multicollinearity between independent variables in regression analysis. Statistical significance was defined as $p \leq 0.05$.

## RESULTS

In this study, 413 women were approached, 400 women agreed to participate in the study with a response rate of 96.9%, reasons for not participating were mainly time constraints. The demographic characteristics of the surveyed women are presented in (**Table 1**). The respondent women had a median age of 60 years (IQR = 1) and most of them were married, constituting 73.3% of the sample (293). Regarding educational level, the highest proportion falls within the elementary/secondary school category, comprising 39.3% of respondents ($n$ = 157). Monthly income distribution shows that around three-quarters of the respondents ($n$ = 305) had a monthly income less than 400 JD. The respondents had a median of 6 pregnancies (IQR = 5.0). Additionally, most respondents ($n$ = 362, 90.5%) were menopausal. The median age at menopause among the respondents was 50.0 years (IQR = 6.0). Additionally, the median number of years from menopause was 12.0 years (IQR = 13.0). Concerning chronic medical conditions, 94.5% ($n$ = 378) reported having at least one. The median number of medical conditions per respondent was 2.0 (IQR = 1.0). Almost one third of the patients were 65 years or older 31.3% ($n$ = 125).

The participants had several medical conditions. Ischemic heart diseases were the least reported, affecting 3.5% of participants ($n$ = 14), followed by asthma at 4.8% ($n$ = 19). Hypothyroidism was noted in 9.8% of respondents ($n$ = 39), while hyperlipidemia affected 27.8% ($n$ = 111). A significant portion, 48.8%, reported diabetes ($n$ = 195), and hypertension was the most prevalent condition, affecting 73.3% of participants ($n$ = 293).

Among the participants, more than one-quarter ($n$ = 113, 28.3%) confirmed consuming caffeine. Exposure to sunlight

**Table 1.** Participants' characteristics and health factors (*n* = 400)

| Parameters | Median (IQR) | *n* (%) |
|---|---|---|
| Age (years) | 60.0 (11.0) | |
| Marital status | | |
| Married | | 293 (73.3) |
| Single | | 17 (4.3) |
| Divorced | | 10 (2.5) |
| Widow | | 10 (2.5) |
| Educational level | | |
| Not educated | | 104 (26.0) |
| Elementary/secondary school | | 157 (39.3) |
| High school | | 88 (22.0) |
| BSc | | 50 (12.5) |
| MSc/PhD | | 1 (0.3) |
| Monthly income | | |
| < 200 JD | | 148 (37.0) |
| 200-399 JD | | 155 (38.3) |
| 400-799 JD | | 96 (24.0) |
| ≥ 800 JD | | 1 (0.3) |
| Wears scarf | | |
| Yes | | 399 (99.8) |
| No | | 1 (0.3) |
| Number of pregnancies | 6.0 (5.0) | |
| Menopausal | | |
| Yes | | 362 (90.5) |
| No | | 38 (9.5) |
| Age at menopause (years) | 50.0 (6.0) | |
| Years from menopause | 12.0 (13.0) | |
| Number of medical conditions | 2.0 (1.0) | |
| High caffeine intake | | |
| Yes | | 113 (28.3) |
| No | | 287 (71.8) |
| Exposure to sunlight | | |
| Minimal | | 217 (54.3) |
| Moderate | | 121 (30.3) |
| Good | | 62 (15.5) |
| Vitamin D status | | |
| Normal | | 69 (17.3) |
| Insufficiency | | 36 (9.0) |
| Deficiency | | 30 (7.5) |
| Missing data | | 265 (66.3) |
| Estrogen ever use | | |
| Yes | | 2 (0.5) |
| No | | 397 (99.3) |
| Missing data | | 1 (0.3) |
| Taking calcium supplements | | |
| Yes | | 120 (30.0) |
| No | | 280 (70.0) |
| Taking vitamin D supplements | | |
| Yes | | 42 (10.5) |
| No | | 358 (89.5) |
| Chronic medical conditions | | |
| Yes | | 378 (94.5) |
| No | | 22 (5.5) |

Note. 1 JD = 1.41 US dollar

**Table 2.** Frequencies of FRAX® score attributes (*n* = 400)

| Parameters | Median (IQR) | *n* (%) |
|---|---|---|
| BMI (mg/kg$^2$) | 31.0 (6.9) | |
| Previous fracture | | |
| Yes | | 95 (23.8) |
| No | | 305 (76.3) |
| Parent fractured hip | | |
| Yes | | 21 (5.3) |
| No | | 379 (94.8) |
| Current smoking | | |
| Yes | | 23 (5.8) |
| No | | 377 (94.3) |
| Glucocorticoid use | | |
| Yes | | 7 (1.8) |
| No | | 393 (98.3) |
| Rheumatoid arthritis | | |
| Yes | | 8 (2.0) |
| No | | 392 (98.0) |
| Secondary osteoporosis | | |
| Yes | | 0 (0.0) |
| No | | 400 (100) |
| Alcohol 3 or more units/day | | |
| Yes | | 1 (0.3) |
| No | | 399 (99.8) |
| Femoral neck BMD (g/cm$^2$) | | |
| Yes | | 27 (6.8) |
| No | | 373 (93.3) |
| Ten-year major osteoporotic score | 4.0 (3.3) | |
| Risk of major osteoporotic[^] | | |
| Yes | | 0 (0.0) |
| No | | 400 (100) |
| Ten-year hip fracture score | 0.7 (1.0) | |
| Risk of hip fracture[#] | | |
| Yes | | 37 (9.3) |
| No | | 363 (90.8) |

Note. [^]Ten-year major osteoporotic score ≥ 20% & [#]Ten-year hip fracture score ≥ 3%

varied, more than half of the participants reported minimal exposure. Regarding vitamin D status, unfortunately only 66.3% (*n* = 265) of the participants did not have their vitamin D status checked. Details of respondents' characteristics, other health factors, estrogen, calcium, and vitamin D consumption are presented in **Table 1**.

Key health parameters were analyzed to assess fracture risk using the FRAX® score and are presented in **Table 2**. The median BMI was found to be 31.0 mg/kg$^2$ (IQR = 6.9). Notably, 23.8% of participants (*n* = 95) reported a history of previous fractures, and few women were current smokers. Additionally, only 27 (6.8%) of the participants performed DEXA, but none had their results, so all the FRAX® scores were without BMD.

The characteristics of the participants who had the DEXA were identified, 92.65 (*n* = 25) of these women were postmenopausal. One hundred and twenty-five women were 65 years or older, but only 6.4% (*n* = 8) had the DEXA procedure.

The median ten-year major osteoporotic score was 4.0 (IQR = 3.3). None of the respondents showed a risk for major osteoporotic events. In contrast, the median ten-year hip fracture score was lower at 0.7 (IQR = 1.0), with only 9.3% of individuals showed a risk of hip fracture. If FRAX® score is 3% or more for hip fracture, or 20% or more for other major osteoporosis fractures, woman may be at increased risk of fracture. So, in this study none of the respondents were at increased risk of fracture. More than half of the participants were obese, 58.5% (*n* = 234).

In the final analysis, both univariate and multivariate linear regression were conducted to assess predictors influencing women's ten-year major osteoporotic score and ten-year hip fracture score.

The findings revealed that higher age at menopause longer duration since menopause were predictors of higher scores for major osteoporotic fractures ($p < 0.001$). Additionally, the analysis revealed that higher age at menopause longer duration since menopause were predictors of higher scores for hip fractures ($p < 0.001$), please refer to **Table 3**.

**Table 3.** Assessment of predictors affecting women ten-year hip fracture and major osteoporotic score

| Parameter | Ten-year hip fracture score | | | | Ten-year major osteoporotic score | | | |
|---|---|---|---|---|---|---|---|---|
| | Univariate linear regression | | Multivariate linear regression | | Univariate linear regression | | Multivariate linear regression | |
| | Beta | p-value[#] | Beta | p-value[$] | Beta | p-value[#] | Beta | p-value[$] |
| Marital status | | | | | | | | |
| Ever married (married, divorced, or widow) | Reference | | | | Reference | | | |
| Single | -0.014 | 0.779 | - | - | 0.025 | 0.616 | - | - |
| Educational level | | | | | | | | |
| High school or lower | Reference | | | | Reference | | | |
| BSc or higher | -0.132 | 0.008[^] | -0.002 | 0.955 | -0.114 | 0.023[^] | 0.017 | 0.678 |
| Monthly income | | | | | | | | |
| < 400 JD | Reference | | | | Reference | | | |
| ≥ 400 JD | -0.057 | 0.257 | - | - | -0.004 | 0.936 | - | - |
| Number of pregnancies | 0.150 | 0.003[^] | 0.016 | 0.681 | 0.156 | 0.002[^] | 0.037 | 0.380 |
| Age at menopause (years) | -0.087 | 0.100[^] | 0.319 | <0.001[*] | -0.111 | 0.036[^] | 0.236 | < 0.001[*] |
| Years from menopause | 0.660 | < 0.001[^] | 0.823 | <0.001[*] | 0.600 | <0.001[^] | 0.707 | < 0.001[*] |
| Chronic medical conditions | | | | | | | | |
| No | Reference | | | | Reference | | | |
| Yes | 0.115 | 0.021[^] | -0.011 | 0.767 | 0.143 | 0.004[^] | 0.023 | 0.585 |
| Caffeine intake | | | | | | | | |
| No | Reference | | | | Reference | | | |
| Yes | -0.093 | 0.064[^] | 0.033 | 0.381 | -0.093 | 0.062[^] | 0.017 | 0.694 |
| Exposure to sunlight | | | | | | | | |
| Minimal | Reference | | | | Reference | | | |
| Moderate/good | -0.063 | 0.211[^] | 0.024 | 0.520 | -0.048 | 0.336 | - | - |
| Estrogen ever use | | | | | | | | |
| No | Reference | | | | Reference | | | |
| Yes | -0.038 | 0.450 | - | - | -0.039 | 0.433 | - | - |
| Taking calcium supplements | | | | | | | | |
| No | Reference | | | | Reference | | | |
| Yes | 0.030 | 0.553 | - | - | 0.060 | 0.228[^] | 0.038 | 0.397 |
| Taking vitamin D supplements | | | | | | | | |
| No | Reference | | | | Reference | | | |
| Yes | -0.076 | 0.128[^] | 0.002 | 0.964 | -0.085 | 0.088[^] | -0.038 | 0.399 |

Note. 1 JD = 1.41 US dollar & [*]Significant at 0.05 significance level

## DISCUSSION

The FRAX® score is a valuable tool in calculating the 10-year probability of obtaining a major fracture and hip fracture. This tool allows the prediction with or without the DEXA and can help in early identification of those who are at the greatest risk of fracture, in order to provide to them immediate preventive measure. BMD has certain limitations that the FRAX® score address, which includes its insensitivity to those who experience fractures and do not reach threshold for densitometric osteoporosis. Consequently, these patients will be deprived of appropriate treatment [4].

Despite its cost-effectiveness, and its incorporation in many international guidelines [13], it is not a common practice to use the FRAX® score in clinical practice in Jordan. This is pivotal, especially in a healthcare system that overwhelmed and with limited resources like Jordan.

Most of our participants were from low-income families, which is expected since most of the visitors of governmental healthcare centers are with low-middle income. More than half of the participants had minimal exposure to sunlight, 54.3%. this might affect the vitamin D level since its primary source of production is in the skin after exposure to ultraviolet radiation [14]. However, we could not link sun exposure to vitamin D status since 66% of the participants did not have their vitamin D level tested.

Only two participants ever used estrogen, which is not commonly used by women in Jordan. Oral contraceptives are not appealing to women in Jordan and only 8% of women in childbearing age use it for family planning [15]. One third of the patients used calcium supplements, this value is comparable to previous results shown in [10], where 32% used calcium supplements. The role of calcium supplements for bone health is controversial. It was conducted an analysis to evaluate the effect of calcium supplement on lumbar spine and femoral neck B BMD. Calcium supplement use was associated with less BMD loss [16]. On the contrary, it was shown in their review that calcium has a negative risk-benefit effect and that supplements/dietary intake from < 400 to > 1,500 mg per day in healthy older women was not associated with the rate of bone loss over 5 years [17]. Supplements have a short-term effect on reducing bone resorption [17].

Only 10.5% of the participants used vitamin D supplements which is lower than previously reported in a previous study [10]. This might be explained by the fact that many participants did not have their vitamin D status checked. Seventeen percent of the participants had insufficiency/deficiency in vitamin D, but only 10% of the participants received vitamin D supplements. This percentage is extremely lower than results revealed in [18] in Jordan where they reported vitamin D insufficiency in 10.1% of the females and deficiency in 78.5%. Unfortunately, findings from our study are not complete since only 33.8% ($n$ = 135) had their vitamin D status checked. We predict that the percentage of vitamin D deficiency is higher,

vitamin D test is expensive, and it is not a routine test in standard healthcare.

Our results showed that only 27 participants had previously done a DEXA, but unfortunately the results were not available, the patients did not remember the results, or they were not found in the electronic health records. Only 6.4% of the participants 65 years or older had DEXA. Many guidelines recommend that all women 65 years and older and men 70 years and older should be screened for asymptomatic osteoporosis [18, 19]. This low percentage demonstrates a gap in the detection of women with osteoporosis and delays appropriate therapeutic management. This is particularly important since the prevalence of osteoporosis among Jordanian postmenopausal women was 37.5% [20]. Moreover, The cut off point of 65 years for women may be applicable for western countries with higher life expectancy, but it might not be applicable in countries with shorter life expectancy [21]. In Egypt, a Middle Eastern country, they recommend screening for osteoporotic fracture risk (using the Egyptian FRAX®) in both women and men aged 50 years or older. Those who have a high or very high 10 years FRAX® risk of fracture probability should have BMD testing by DEXA [21].

Although FRAX® is a valuable tool and is cost-effective, it has its drawbacks. FRAX® without BMD is well calibrated to predict 10-year hip fractures and fragility fractures, but FRAX® with BMD is well calibrated to predict 10-year fragility fractures but may be poorly calibrated to predict 10-year hip fractures [22].

Considering the different attributes of the FRAX® score, median BMI was 31 which indicates the prevalence of obesity among the participants. It was conducted a study that examined the prevalence of obesity in Jordan that included 1,193 men and 2,863 women between 18-90 years. The prevalence of obesity was higher in women than men, 75.6% and 60.4%, respectively [23]. Based on the results in [23] and a former study in [24], obesity in Jordan has increased in the last two decades.

The ten-year risk for major osteoporotic score and hip fracture score is lower than that in other studies in Malyasia [25], and Hong Kong [26]. This is probably due to the differences of study population in terms of age, gender, and osteoporotic or not.

Education level, number of pregnancies, and presence of chronic medical condition were statistically significant predictors of the higher risk for ten-year major osteoporotic fracture in the univariate analysis but not in the multivariate model. It was revealed that women with lower education level were more likely to have osteoporosis [10].

In the multivariate regression, predictors for ten-year risk of hip fracture and major osteoporotic fracture were age at menopause and years from menopause. Every year menopause increases the risk of hip fracture by 0.823 and major osteoporotic fracture by 0.707. Similar results were shown in Malaysia where years of menopause was associated with the probability of major osteoporotic and hip fractures using the FRAX® score [25]. Cells responsible for bone remodeling have receptors that are susceptible to estrogen [27], decreased exposure to estrogen caused by longer years of menopause enhances bone resorption and leads to bone loss. In a study conducted in Jordan revealed that years elapsed since menopause was a statistically significant predictor of osteoporosis [20]. Similar results of longer postmenopausal period in women with lower bone density was found in other studies [28, 29].

This is the first study to evaluate the FRAX® score in Jordanian women and explore possible predictors of a high fracture probability. Based on our findings, early identification of women with longer years of menopause who may have higher FRAX® score might provide these women with better preventive measures.

The study has several limitations including the absence of certain lab tests, such as vitamin D, that does not provide the whole picture. Some information related to habits and lifestyle was provided by the participants which might be overestimated or underestimated by the participants. Recall bias is another factor that might influence data, since participants depended on their memory. The participants were from a governmental healthcare centre that serves tens of thousands of citizens. Governmental medical institutions are attended by most Jordanians and serve most of the population. However, women who attend clinics in private sector were not included in the study which might affect the generalizability of results.

## CONCLUSION

The use of the FRAX® score in standard healthcare services is absent despite its cost-effectiveness. The score can be used as a tool to predict the ten-year major osteoporotic fracture and hip fracture with or without DEXA. Consequently, it is of great value in Jordan where the BMD measurement by DEXA is not a common practice. Using the FRAX® score for early identification of women with high risk, especially those with longer years of menopause may offer these women an opportunity of early preventive measures. It is our recommendation to implement the use of the FRAX® score in primary healthcare centres by family physicians and general practitioners as a valuable tool for preliminary fracture risk prediction.

**Author contributions:** **LG:** conceptualization, formal analysis, methodology, writing the original draft, & supervision; **MA:** conceptualization, methodology, writing the original draft, & supervision; **ZL:** conceptualization, formal analysis, methodology, & writing the original draft; **RKA-F:** formal analysis, methodology, & writing the original draft; & **AY, NS, NA, & MG:** data curation, supervision, & writing original draft. All authors have agreed with the results and conclusions.

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**Declaration of interest:** No conflict of interest is declared by the authors.

**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

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