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# Osteoporotic fracture risk evaluation

## Options when central densitometry is not available

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**Background:** Osteoporosis-related fractures represent a major health problem. Although spine and hip bone densitometry is the gold standard to assess bone density, this test is not always accesible. The purpose of this study was to describe two options to assess the risk of fracture due to osteoporosis in post-menopausal women assigned to a primary care unit where bone densitometry is not available.
**Methods:** A cross-sectional study was conducted in 332 post-menopausal women without diagnosis or treatment for osteoporosis, attending regularly to a primary care unit. A heel bone peripheral densitometry, physical exam and medical history were performed. The assessment of fracture risk was carried out using the FRAX™ method.
**Results:** Mean age was 60 ± 8.7 years and body mass index was 28.68 ± 4.24. According to the heel bone peripheral densitometry, 19 (5.7 %) women had osteoporosis (T-score less than or equal to –2.5), 171 (51.8 %) had osteopenia (T-score between –2.5 and less than or equal to –1) and 141 (42.5 %) had normal bone mineral density. According to the FRAX method, 13 (3.9 %) had an increased risk of osteoporotic fracture in a 10-year period and 40 (12 %) of hip fracture.
**Conclusions:** There was low concordance in the 10-year risk for major osteoporotic fracture and hip fracture assessed with both the FRAX™ and the peripheral bone densitometry methods.

**Keywords** | **Palabras clave**
Osteoporotic fractures | Fracturas osteoporóticas
Bone density | Densidad ósea
Photon absorptiometry | Absorciometría de fotón

Osteoporosis is the most common metabolic bone disease. It affects up to 40 % of post-menopausal women. Osteoporosis is considered a silent disease because bone loss occurs without symptoms or signs. Approximately two-thirds of vertebral fractures are asymptomatic. In many cases clinical osteoporosis is recognized by the occurrence of fracture after minimal trauma.[1] The number of elderly individuals is increasing with the rising of life expectancy worldwide. It has been estimated that the incidence of hip fracture will rise from 1.66 million in 1990 to 6.26 million by 2050.[2] Annual rate of hip fracture published in 2005 by the two main public health care systems of Mexico, was 169 in women and 98 in men per 10 000 person-year; that corresponds to one out of every 12 women 50 year-old in Mexico will have a hip fracture. It has been estimated that the cost of treatment of osteoporotic fracture per year is more than 36 million dollars for one of the most important Mexican health care system.[3]

The bone mineral density (BMD) measurements have an important role in the evaluation of patients at risk of osteoporosis. The preferred method of testing is the central dual energy X-ray absorptiometry scan (DXAS) to measure BMD of the lumbar spine and hip. The T-score definition obtained by the DXAS measure is considered the gold standard in the diagnosis of osteoporosis for the World Health Organization.[4] However, DXAS scan has two problems for developing countries: the cost and the unavailability of the equipment in many little localities, especially in poorer rural areas.[5]

In recent years the World Health Organization had proposed the use of a fracture risk assessment tool (FRAX™) for individual estimation of 10-year major osteoporotic and hip fracture probabilities.[6] This has led to broad endorsement of FRAX™ and its integration into several clinical practice guidelines. For example, subjects with a 10-year major osteoporotic fracture probability greater than or equal to 20 % or 3 % for hip fracture are considered an indication for intervention according to the National Osteoporosis Foundation (NOF).[7] The World Health Organization has proposed that FRAX™ could be used without BMD value in that regions where DXAS is not available and it is an alternative approach to evaluate people at risk of osteoporotic fracture.

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**Evaluación del riesgo de fracturas osteoporóticas. Opciones a la densitometría central**

**Resumen**

**Introducción:** las fracturas relacionadas con la osteoporosis son un problema de salud. Aunque la densitometría ósea de columna y cadera es el estándar para evaluar la densidad ósea, no siempre es accesible. El objetivo de este estudio fue describir dos alternativas a la densitometría ósea para evaluar el riesgo de fractura por osteoporosis en mujeres posmenopáusicas.
**Métodos:** estudio transversal de 332 mujeres posmenopáusicas sin diagnóstico o tratamiento de osteoporosis, que asistían regularmente a una unidad de primer nivel. Se realizó densitometría periférica de talón, examen físico e historia médica. La evaluación del riesgo de fractura se llevó a cabo mediante FRAX™.
**Resultados:** la edad media fue de 60 ± 8.7 años y el índice de masa corporal de 28.68 ± 4.24. Según la densitometría periférica de talón, mujeres 19 (5.7 %) tenían osteoporosis (T-score menor de –2.5), 171 (51.8 %) osteopenia (T-score entre –2.5 y menos de –1) y 141 (42.5 %) densidad mineral ósea normal. Según el método FRAX, 13 (3.9 %) tenían riesgo aumentado de fractura osteoporótica en un periodo de 10 años y 40 (12 %) de fractura de cadera.
**Conclusiones:** la prevalencia de riesgo para osteoporosis es diferente de acuerdo con el método que se utilice para medirlo. La concordancia entre los dos métodos fue baja.

Because osteoporosis is common and usually it is managed in primary care, a cheap and suitable method of evaluating osteoporosis risk fracture without BMD is necessary.[5,8] Peripheral dual energy X-ray absorptiometry scan (pDXAS) might fulfill this role, pDXAS is an established method of assessing skeletal status, and with the advantages of low cost and portability, it is recognized as an alternative tool for identifying individuals at risk of fracture.[9] It is accepted that osteoporosis could not be diagnosed with pDXAS, however this tool has the advantage over central DXAS that is cheaper, transportable and use less ionizing radiation. The low cost and easy transportability become pDXAS in an useful tool in the osteoporosis detection when cost or instrument inaccessibility to a central DXAS is difficult or impossible.[10,11] The primary care is the best opportunity to prevent osteoporotic fractures in postmenopausal women, unfortunately the decision of beginning therapy at primary care unit is difficult, the most of the times has to be done without central DXAS results. The aim of this study was to describe two different approaches in the evaluation of osteoporosis risk fracture in postmenopausal women attending a primary care level unit, where central DXAS is not available to measure central BMD.

## Methods

All participants were consecutive, unselected postmenopausal women. Who assisted for general medical check in the Primary Care Unit # 222 in the Instituto Mexicano del Seguro Social (IMSS), Toluca, Mexico, between 2009 and 2010. All patients were invited to participate. We include postmenopausal Mexican mestizo ethnic women, without previous diagnosis of osteoporosis or treatment. Women were considered postmenopausal if they had not menstruated within the last 12 months before the examination. Body height and weight were measured at baseline examination in a standing position without outer clothes and without shoes. Height and weight were used to calculate BMI (kilograms per meter squared). A structured validated questionnaire that include osteoporosis related risk factors was administered by the physician.

FRAX™ scores were calculated manually from the FRAX™ *(http://www.shef.ac.uk/FRAX).* The Mexican version of FRAX™ was used for all subjects. The 10-year probabilities of major osteoporotic and hip fracture were recorded for FRAX™; all calculation was performed without BMD value. The FRAX™ tool was designed to be used with central DXAS data, and we used it following the recommendation of World Health Organization for using this tool when the data of central DXAS is not available. We consider women at risk those with 10-year major osteoporotic fracture probability of greater than or equal to 20 %, and/or 3 % for hip fracture following the recommendation of NOF.

Measurements of calcaneal BMD (g/cm$^2$) was performed using peripheral DXAS, PIXI (Peripheral Instantaneous X-ray Imager, GE Lunar Corporation, Madison, WI, USA). The World Health Organization definitions of osteopenia (BMD T-score between −1 and −2.5) and osteoporosis (BMD T-score less than or equal to −2.5) were applied and the calcaneal BMD.

Statistical analysis was performed using SPSS software V17 (Microsoft, San Diego, CA). Descriptive statistics are presented as mean values and standard deviation. Variables were tested for normality using the Kolmogorov-Smirnov test. In relations with a normality distribution, Pearson's or Spearman's correlation coefficients were calculated to examine the relationship between variables. Student t-test or the Mann-Whitney U-test was used for comparisons of two groups. Kappa index was calculated for evaluate the concordance between both methods.

The study received ethical approval by the local Institutional Review Board, and all subjects gave written informed consent to participate.

## Results

A total of 332 postmenopausal women were included. Mean age was 60 ± 8.7 years. Mean menopause age was 50 ± 2.1 years. Mean BMI was 28.68 ± 4.24 kg/m$^2$. Two hundred fifty eight (73.4 %) patients were obese or overweight.

Thirteen women (3.9 %) were considered at risk of having osteoporotic fracture in a 10 years period, and 40 (12 %) for hip fracture using the FRAX$^{TM}$ tool according to the NOF recommendations. Thirteen women in risk of osteoporotic fracture in a ten years period were also considered at risk for hip fracture. The most common risk factor for osteoporosis was premature menopause present in 46 % of the patients (table I).

In pDXAS according to the World Health Organization classification, 19 women (5.7 %) fell in the range of osteoporosis, 172 (51.8 %) in osteopenia and 141 (42.5 %) with normal T-score. Pearson correlation was performed, obtaining a negative correlation between BMD and age ($r^2$ of – 0.445, $p < 0.001$), likewise found a positive correlation between BMD and weight ($r^2$ of 0.209, $p < 0.001$).

Only eight patients were defined as high 10 years risk for fracture with FRAX$^{TM}$ and also were categorize with osteoporosis according World Health Organization with pDXAS. The kappa index identifying women in risk to develop a osteoporosis related fracture in the next 10 years period with the two tools (FRAX$^{TM}$ and pDXAS) was $\kappa = 0.203$. When we exclude the eight patients that were considered in risk in both methods, those with diagnostic of osteoporosis according pDXAS seems to be younger than those categorized at high risk according FRAX$^{TM}$ (table II).

## Discussion

In the study we described the prevalence of osteoporotic risk factors and the characteristics of bone mineral density, in post menopausal women without previous diagnostic or treatment of osteoporosis, who attend to a primary care level center, where central DXAS of hip and lumbar spine is not available. We use two cheap tools (FRAX$^{TM}$ and pDXAS to look for those women who were in high risk to develop a osteoporotic fracture. In our sample population the tools seems to identify different patients. Due the cross-sectional design of this study, the aim was neither to evaluate nor to compare the effectiveness of both tools for predicts osteoporotic fractures. The aim of this study was to describe the results of osteoporotic risk factors evaluation using two different tools, in a postmenopausal women population who attend to a primary care center where central DXAS is not available.

Osteoporosis and fragility fractures have recently become a focus of research in Mexico, where one out of twelve Mexican women and one out of four Mexican men over 50 years of age will sustain a hip fracture in the remaining years of their life.[12] According a study in our health system, the cost of hospitality care of hip fracture in postmenopausal women was more than 36 million dollars in two years.[13] Identification of individuals at high risk of osteoporotic fracture is important to develop strategies to reduce the burden of such fractures. Moreover preliminary calculations estimate that the number of dedicated (DXAS) units required to assessment the population at risk is at least, eight per each million of inhabitants. Unfortunately, neither the most developing countries meet this requirement.[14] So it is advisable to promote research on the appropriate use of cheaper and portable diagnostic alternatives, and others tools.

A number of authors have investigated the ability of peripheral devices to measure the density and microarchitectural properties of bone.[8,15,16] The peripheral devices measures had not a close correlation with central BMD measures by central DXAS. The measurements obtained with them are not the same to define osteoporosis according World Health Organization criteria.[17] However pDXAS is an accepted method of assessing skeletal status, and because of the advantage of low cost and portability, pDXAS is an alternative tool for identifying individuals at risk of fracture.[10] The heel pDXAS use for measure BMD, when is obtained with appropriate triage thresholds, can help to identify patients suitable for fracture prevention treatment.[18] It has been shown that peripheral and central measures are equally used in the clinical risk fractures for osteoporosis estimation.[9]

In our study we found that the combined percentage of patient with osteopenia-osteoporosis is almost 60 % in our population; This seems to be lower that reported by Lago Acosta[19] using the same method in Mexican population; he reported approximately of 80 % of patients with osteopenia-osteoporosis. The difference between both studies is that in our study we only considered patients without previous diagnosis or treatment for osteoporosis, so we estimate the incidence not the prevalence of the disease. In the case of Lago Acosta study, it was made in open population from different care units considering both sex (men and women) with or without previous diagnosis or treatment of osteoporosis. The same explanation could be applied to the different findings reported by Rojano

**Table I** Characteristics of 332 patients with osteoporotic risk fracture evaluation

| | | |
|---|---|---|
| Age (years) | 60.07 ± 8.73 | |
| Weight (kg) | 66.31 ± 10.04 | |
| Body mass index | 28.68 ± 4.27 | |
| Bone mineral density (g/cm$^2$) | 0.466 ± 0.11 | |
| | *n* | % |
| Previous fracture | 83 | 25.0 |
| Parent fractured hip | 34 | 10.2 |
| Current smoking | 27 | 8.1 |
| Glucocorticoids | 12 | 3.6 |
| Rheumatoid arthritis | 43 | 13.0 |
| History of long-standing hyperthyroidism | 14 | 4.2 |
| Alcohol 3 or more units/day | 5 | 1.5 |
| Type I diabetes | 4 | 1.2 |
| Hypogonadism or premature menopause (< 45 years) | 154 | 46.4 |

Mejía[20] using central DXAS in which previous diagnosis or treatment of osteoporosis were not consider.

Historically, fracture risk assessment in individuals without a clinical diagnosis of osteoporosis based upon established fragility fractures was determined only by BMD measurements. Recently, the use of clinical risk factors has been shown to enhance the performance of BMD in the prediction of hip and major osteoporotic fractures.[21]

The World Health Organization fracture risk assessment tool FRAX™ allows estimation of individual 10-year major osteoporotic and hip fracture probabilities.[6] Analyses have confirmed that there is improvement in fracture prediction using BMD and clinical risk factors together compared with using either BMD alone or clinical risk factors only. This has led to broad endorsement of FRAX™ and its integration into clinical practice guidelines.[22,23] For example, a 10-year major osteoporotic fracture probability greater than or equal to 20 % is considered in high risk and it is an indication for intervention according to the NOF of the United States and Osteoporosis Canada Group. The NOF also recommends that a 10-year hip fracture probability greater than or equal to 3 % is considered for clinical intervention, in addition to those with any BMD measurements in the osteoporotic range and those with prior spine or hip fractures.[24]

The World Health Organization recommends that FRAX™ tool could be used with out the measurement of BMD in those places where central DXAS is not available. Recent publication has shown that FRAX™ tool used with or without BMD has similar performance.[25] In Mexican health services primary care units represents approximately 95 % of all medical services.[26] Primary care level decisions have a big impact in Mexican health costs. Osteoporosis treatment represents a big challenge for the most primary care physicians; decision of treatment has to be done most of the time without information of central DXAS measures.

According to results from our study the using of pDXAS only, suggested that 5.7 % of our population will need medical preventive intervention. When we use only Mexican FRAX™ without the measurement of BMD according of WHO recommendation 12 % of the patient perhaps could be considered for intervention. There is a lack of concordance between tools, only eight patients (2.4 %) would qualify for intervention in both tools. The difference found between both tools could be related that FRAX™ estimates the risk in a 10 years period using several risk factors, and the pDXAS estimates the bone status in the current time. In our study, patients found in ten years risk according to FRAX™ seem to be older than the patient found with osteoporosis in pDXAS.

Some authors had mentioned several limitations for FRAX™. Some of those limitations are: may only be used in untreated patients, poor definition of secondary osteoporosis, relationship between BMI and mortality, variability in fracture rates.[27] One of the big concerns is the ethnicity variability. New data had been published with different countries experiences.[28,29] This variability could be important, as shown by Nasser[30] who compare South Californian women of Mexican descent using US Hispanic and Mexican databases. Differences were noted in the absolute number of hip fracture subjects at risk. However FRAX™ is a major achievement in terms of our understanding of measuring fracture risk. It is the only model based on extensive data on multiple cohorts with and without BMD that has been validated in additional cohorts.

**Table II** Difference in women considered in high risk of osteoporotic fractures according each tool

| | FRAX™ (*n* = 32) | DXAS (*n* = 11) | *p** |
|---|---|---|---|
| Age (years) | 72.6 ± 1.1 | 62.4 ± 3.2 | < 0.001 |
| Weight (kg) | 63.6 ± 1.6 | 62 ± 2.8 | 0.69 |
| Body mass index | 27.5 ± .01 | 28.4 ± .79 | 0.45 |
| T-score | –1.47 ± 0.12 | –2.7 ± 0.04 | < 0.001 |
| Z-score | –0.22 ± 0.13 | –1.9 ± 0.14 | < 0.001 |
| Bone mineral density (g/cm$^2$) | 0.416 ± 0.014 | 0.278 ± 0.004 | < 0.001 |

DXAS = dual energy X-ray absorptiometry scan
Patients who were positives in both tools were excluded for this analysis
**p* value was calculated with Student-t test or Mann-Whitney U-test as appropriate

FRAX™ could help clinicians to identify individuals who need osteoporosis preventive interventions and also individuals who do not need osteoporosis treatment. There are not prospective studies that compare the cost effectiveness of treat patient using these methods in developing countries. Interventions patients with risk of osteoporotic fracture in primary care level, remains to be a big challenge for health systems authorities.

We considered that results showed with both tools could be useful to identify patients at risk of having a osteoporotic fractures, however the patients found seems to be different, in each method the appropriate intervention should be individualized according to patient characteristics and local health resources. Future prospective studies needs to be done to see the real impact of the reduction of fractures using this tools in primary care level.

## Conclusions

In the present study using two different approaches that could be more commonly available in primary care units. Both tools are easy and convenient to use in primary care units, however they seems to identify different patients. The limitations of this study is the cross sectional design and that was made only in one primary care unit. The strength of this study is that is the first one that compare this two approaches in primary care level in post-menopausal women without previous diagnosis or treatment of osteoporosis.

**Conflict of interest disclosure:** the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest has been completed and delivered by the authors. It hasn't been reported any conflict in regards to this article.

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