Original Research Article

The assessment of FRAX-based osteoporotic fracture risk probability among nurses aged 40 and above in a tertiary care hospital in Sri Lanka

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Abstract

Data related to the probability of osteoporotic fracture risk among nurses are not available in Sri Lanka. FRAX (Fracture Risk Assessment Tool) can assess fracture risk without bone mineral density (BMD) values when Dual energy x-ray absorptiometry is not available. This study analyzes the FRAX-based 10-year major osteoporotic fracture probability (MOFP) and the hip osteoporotic fracture probability (HOFP) among nurses aged 40 years and above in a tertiary care hospital in Sri Lanka. A standard questionnaire was administered to collect data on socio-demographic characteristics and clinical risk factors for osteoporosis. Partial correlation analysis was used to analyze the association between fracture risk probability and body mass index (BMI) or duration of menopause. Of the 200 study subjects, Sinhalese constituted the majority (98.5%, n=197) with a mean age of 48.5±5.5 years. Menopause was significantly correlated with FRAX-based 10-year MOFP and HOFP estimated without consideration of BMD ($p<0.001$). The FRAX-based 10-year MOFP and HOFP estimated without consideration of BMD were 1.82% and 0.27%, respectively. A significant positive association was observed between menopausal duration and FRAX-based fracture probability after adjustment for age and BMI, while a significant negative association between BMI and FRAX-based fracture probability after adjustment for age was also identified. Further, a statistically significant association was observed between menopausal duration and FRAX-based 10-year MOFP ($p=0.03$) and between BMI and FRAX-based 10-year HOFP ($p=0.001$), without consideration of BMD. In conclusion, MOFP and HOFP estimated without consideration of BMD among Sri Lankan nurses aged 40-years and above were very low and were below the FRAX-based treatment thresholds. Further studies involving several healthcare institutions and BMD values are encouraged to confirm our results.

Keywords: FRAX; bone mineral density; osteoporosis; fracture; nurses

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Introduction

Osteoporotic fractures are common among postmenopausal women, with high morbidity and mortality (1,2). Spine and hip fractures are the two most serious fracture types. Osteoporosis is a silent disease that is difficult to detect at an early stage as bone loss occurs without symptoms and signs. It also entails a significant cost to society by causing hospitalizations, necessitating advanced investigations, increasing nursing home stays, and diminishing patient performance in social responsibilities (3-5). It has been estimated that more than 50% of all osteoporotic hip fractures in the world will occur in Asia by the year 2050 (6). Furthermore, several studies have demonstrated that there were 5-30% treatment rates for osteoporosis following hip fractures (7,8). Therefore, it is critical to identify those who are at risk for an osteoporotic fracture early and to prevent future fractures once a fragility fracture has been diagnosed.

The Fracture Risk Assessment Tool (FRAX) is a computer-based algorithm developed in 2008 by the World Health Organization Collaborating Centre for Metabolic Bone Disease (9,10). FRAX is currently available online at http://www.shef.ac.uk/FRAX. The tool calculates the 10-year probability of a major osteoporotic fracture in the hip, spine, humerus, or wrist (11). This probability is calculated by considering the age, sex, body mass index (BMI), history of fragility fracture, parental history of hip fracture, current tobacco smoking, use of long-term oral glucocorticoids, rheumatoid arthritis, causes of secondary osteoporosis, and consumption of alcohol. In addition, femoral neck bone mineral density (BMD) is an optional measure that can be included to enhance fracture risk prediction (10). Previous research has shown that estimated probability of FRAX-based 10-year osteoporotic fracture risk was lower than the actual fracture rate among women with low BMD (12,13).

Dual-energy x-ray absorptiometry (DXA) is considered the gold standard for assessing BMD (14-16). However, affordability and availability of DXA are the two major barriers that arise with BMD measurement. Even though quantitative ultrasound (QUS) is cheap, portable, and free of ionizing radiation, the utility of QUS is limited in the field of osteoporosis (17-20).

Caregivers may be particularly vulnerable to bone and muscle diseases due to laborious work in taking care of patients, inadequate exposure to sunlight, and indoor work environment. Moreover, most of them are in middle age or older, making them highly vulnerable to osteoporosis. Chen et al. have shown that 46.8% of public health nurses falsely considered osteoporosis to be easy to treat and diagnose (21). Further, nursing students of various grade levels, as well as nursing practitioners, have been shown to have inadequate knowledge of risk factors, detection, treatment, and prevention of osteoporosis (22-26). Inadequate knowledge and inherent occupational responsibilities together make nurses more vulnerable to osteoporosis.

Some countries like Sri Lanka used data of a surrogate population to estimate 10-year osteoporotic fracture probabilities. To date, there is no study assessing FRAX-based osteoporotic fracture risk among nurses (27). This study aims to assess the FRAX-based 10-year osteoporotic fracture risk probability among nurses aged 40 years and above at a tertiary care hospital in Sri Lanka. Thereby, early recognition and identification of at-risk candidates will help take

appropriate preventive measures and therapeutic interventions to reduce the burden on individuals as well as on the healthcare system as a whole.

Materials and methods

This cross-sectional study was conducted between January and May 2021. The study population included 200 female nurses aged 40 years or older without a diagnosis of osteoporosis, selected from a tertiary care hospital in Sri Lanka. A simple random sampling method was used to recruit eligible subjects. All study participants provided written informed consent, and the study was approved by the medical ethics committee of the institution. A questionnaire was used to collect information on age, level of education, marital status, ethnicity, last regular menstrual period, hormone replacement therapy, and clinical risk factors for osteoporosis.

The BMI was calculated from weight and height, measured by a standard weighing machine and stadiometer, respectively. The same questionnaire was used to gather data to assess the 10-year major osteoporotic fracture probability (MOFP) and the 10-year hip osteoporotic fracture probability (HOFP) by the Sri Lankan FRAX tool. Fracture risk was calculated based on age, BMI, and clinical risk factors without consideration of BMD. BMD was not taken into consideration as DXA facilities are not readily available in all hospitals in Sri Lanka.

Statistical analysis was performed using Statistical Package for Social Science (SPSS, version 26.0) software. Quantitative data are presented as the mean ± standard deviation (SD) and range. Qualitative data are presented as frequencies (percentages). To analyze the association between 10-year fracture risk probability and various categorical variables, the Chi-squared test was utilized. Partial correlation analysis was used to analyze the association between fracture risk probability and BMI or duration of menopause. *P*-values <.05 were considered statistically significant.

Results

In the present study, out of the total study subjects (*n*=200), Sinhalese constituted the majority (98.5%, *n*=197). The mean age of the subjects was 48.5 years ± 5.5 years. 99.5% of the nurses (*n*=199) had diplomas at the time of enrolment in the study. A majority of the study participants did not use hormone replacement therapy (95.5%, *n*=191) (Table 1). Descriptive data on basic characteristics and FRAX-based 10-year osteoporotic fracture probabilities of the study sample are shown in Table 2. Upon analyzing demographic data and osteoporotic fracture probability, there was a statistically significant correlation between FRAX-based 10-year MOFP and HOFP ((*p*<0.001; Table 3).

Analysis of BMI among the study participants revealed that 30.5% (*n*=61) were obese with a BMI greater than or equal to 27, 25% (*n*=50) were overweight with a BMI between 24 to 26.9, 41.5% (*n*=83) were within the normal range with a BMI between 18.5 to 23.9, and 3% (*n*=6) were underweight with a BMI less than 18.5. Significant negative associations were observed between BMI and FRAX-based fracture probability after adjustment for age among the

Table 1. Socio-demographic characteristics of the study sample

Variable		**Frequency, number (%)**
Age (years)	40-50	129 (64.5)
	51-60	68 (34)
	61-70	3 (1.5)
Marital status	Married	182 (91)
	Unmarried	17 (8.5)
	Divorced	1 (0.5)
Ethnicity	Sinhala	197 (98.5)
	Tamil	2 (1)
	Muslim	1 (0.5)
Education level	Diploma	199 (99.5)
	Postgraduate degree	1 (0.5)
Menopause	Yes	83 (41.5)
	No	117 (58.5)
Hormone replacement therapy	No	191 (95.5)
	Used for some time	8 (4)
	Continuous usage	1 (0.5)

overall study subjects. There were statistically significant positive associations between BMI and FRAX-based 10-year HOFP (p=0.001; Table 4). Among the study participants, 41.5% (n=83) of female subjects were postmenopausal females. The duration of menopause ranged from one year to 19 years (mean 5.2 ± 4.0 years). There were significant positive associations between menopausal duration and FRAX-based fracture probability after adjustment for age and BMI among menopausal females. Therefore, a statistically significant association was observed between menopausal duration and FRAX-based 10-year MOFP (p=0.032) (Table 4). However, this study did not show an association between hormone replacement therapy and FRAX-based osteoporotic fracture probability among nurses.

Table 2. Descriptive characteristics and FRAX-based 10-year osteoporotic fracture probabilities

Variable	Mean (SD) / n (%)	Range
Age (Years)	48.5± 5.5	40-67
BMI (kg/m^2)	25.07±4.05	12.8-41.4
Previous fracture	15 (7.5%)	
Parental history of fracture	13 (6.5%)	
Current smoking	0	
History of steroid use	14 (7%)	
Rheumatoid arthritis	6 (3%)	
Secondary osteoporosis	38 (19%)	
Alcohol 3 or more units/day	0	
MOFP without BMD	1.82±1.40	0-9.5
HOFP without BMD	0.27±0.40	0-2.7

Abbreviations: BMD, bone mineral density; BMI, body mass index; HOFP, FRAX-based 10-year hip osteoporotic fracture probability; MOFP, FRAX-based 10-year major osteoporotic fracture probability

Table 3. Comparison of FRAX-based 10-year osteoporotic fracture probabilities according to socio-demographic characteristics

Variable	X^2		*P*	
	Without BMD		Without BMD	
	MOFP	HOFP	MOFP	HOFP
Age	251.793	163.415	<0.001	<0.001
Marital status	41.752	14.84	1.000	0.991
Ethnicity	41.859	9.374	1.000	1.000
Menopause	85.099	59.904	<0.001	<0.001
Hormone replacement therapy	52.395	13.283	0.997	0.986

Abbreviations: BMD, bone mineral density; HOFP, FRAX-based 10-year hip osteoporotic fracture probability; MOFP, FRAX-based 10-year major osteoporotic fracture probability.

Table 4. Associations between BMI and duration of menopause with FRAX-based 10-year osteoporotic fracture probabilities

Variable		Without BMD	
		MOFP	HOFP
BMI	r	-0.112	-0.226
	p	0.115	0.001
Duration of menopause	r	0.153	0.103
	p	0.032	0.147

Abbreviations: BMD, bone mineral density; BMI, body mass index; HOFP, FRAX-based 10-year hip osteoporotic fracture probability; MOFP, FRAX-based 10-year major osteoporotic fracture probability.

Discussion

Osteoporosis screening and evaluation of risk factors allow clinicians to determine which groups require follow-up interventions that reduce their risk for osteoporosis. The FRAX model plays an important role in estimating risk of an osteoporotic fracture within the next 10 years. Many countries have developed their FRAX models using national data, assuming country-specific algorithms suit the local population best.

In this study, we assessed the Sri Lankan FRAX-based 10-year MOFP and HOFP among nurses in a tertiary care hospital. The FRAX-based fracture probabilities (MOFP: 1.82% and HOFP: 0.27%) identified in this study were lower than the fracture probabilities reported in postmenopausal women in Taiwan (MOFP:13.8%, HOFP:2.2%) and Hong Kong (MOFP:6.9%, HOFP: 2.3%) (28,29). Previous studies have shown that non-inclusion of BMD leads to inaccurate estimation of fracture risk (30-32). Gadam et al. found 84% identical fracture risk prediction by FRAX with and without BMD in a multiethnic study sample (33). A similar study showed that the Canadian FRAX tool without BMD is a good predictor of estimating fracture risk among men and women (34). Similarly, Subasinghe et al. demonstrated that Sri Lankan FRAX without BMD input can be an alternative on the clinical ground when there is no access to DXA facility (35). However, to date, there is a range of 76% to 90% agreement between FRAX score estimation with and without BMD (36). Therefore, we estimated the fracture risk probability without BMD, owing to the lack of accessibility to the DXA facility.

Notably, there was a significant negative association between BMI and FRAX-based 10-year fracture probability. Similar to this study, previous studies have shown that there is a nonlinear relationship between BMI and FRAX-based fracture probability and that BMI<18.5 kg/m^2 might be a risk factor for fragility fractures (37-38). The present study shows a statistically significant correlation between menopause and FRAX-based fracture probability. The increased rate of bone resorption after menopause indicates a hormonal influence on bone density in women, probably due to the drop in ovarian estrogen production (39). Moreover, this study shows a statistically significant association between menopausal duration and FRAX-based 10-year MOFP estimated without consideration of BMD. Similar to our results, Demir et al. stated

that osteoporosis is related to the duration of menopause at the time of BMD measurement rather than the age at menopause among postmenopausal women (40). Further, Keramat et al. showed that a postmenopausal period of more than five years is a risk factor for osteoporosis (41). However, this study does not show a statistically significant association between hormone replacement therapy and FRAX-based osteoporotic risk probability. This is likely due to most of the study participants not using hormone replacement therapy (95.5%, *n*=191).

Even though treatment thresholds for osteoporosis based on FRAX were MOFP of ≥20% or HOFP of ≥3%, this study noted that almost all the study subjects have low FRAX-based 10-year MOFP and HOFP (42). This is likely due to the effect of education on lifestyle, healthcare, personal hygiene, nutrition, and economic status.

One limitation of this study was that it was conducted in a single healthcare institution. Therefore, the extrapolation of the results to the entire Sri Lankan nursing community should be performed with caution. Since there is no electronic medical record system in Sri Lanka, we had to rely on the information provided by the study subjects about clinical risk factors to calculate FRAX. However, we verified the information from their health records. Another limitation is that we assessed the 10-year osteoporotic fracture probability without BMD values. Therefore, we encourage future studies including randomized control trials to include multiple healthcare institutions and BMD values to confirm our observations.

Conclusion

This study provides data on FRAX-based 10-year MOFP and HOFP among nurses aged 40 years and above in a tertiary care hospital in Sri Lanka. It showed a statistically significant association between BMI and FRAX-based 10-year HOFP estimated without consideration of BMD. Furthermore, a statistically significant association was observed between menopausal duration and FRAX-based 10-year MOFP estimated without consideration of BMD. However, this study did not show an association between hormone replacement therapy and FRAX-based osteoporotic fracture probability among nurses. After the calculations with the FRAX algorithm without consideration of BMD, MOFP and HOFP among Sri Lankan nurses aged 40 years and above are low and are below the FRAX-based treatment thresholds. Moreover, this study may add substantial value to identifying those with a high risk of osteoporotic fractures in medical facilities where DXA facilities are not available.

Conflicts of Interest

The author has no conflict of interest to disclose

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