Review Article

Screening Tools for Osteoporosis in India: Where Do We Place Them in Current Clinical Care?

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Abstract

The prevalence of osteoporosis is about 40%–50% in postmenopausal women and 20% in older men. The limited availability of dual-energy X-ray absorptiometry (DXA) scanners across the country calls for the presence of alternate risk assessment tools to identify those at high risk for osteoporosis. Some of the screening tools available for osteoporosis include Simple Calculated Osteoporosis Risk Estimation and Osteoporosis Risk Assessment Tool for Asians (OSTA), and Fracture Risk Assessment Tool to assess fracture risk. Clinical parameters that may serve as surrogates include dentition and anthropometric indices. Although screening tools do not supplant the assessment of bone mineral density by DXA, they help identify individuals at high risk for osteoporosis who may be selectively referred for confirming the same.

Keywords: *India, older men, osteoporosis, postmenopausal women, screening tools*

Introduction

Osteoporosis is prevalent in about 40%–50% of Indian postmenopausal women and about 20% of men above 50 years.[1,2] Untreated osteoporosis is a fragility fracture that contributes to heightened economic and societal costs. Moreover, about 20% of postmenopausal women die in the 1st year following a hip fracture.[3] Despite these staggering figures, knowledge gaps exist regarding the screening and treatment for osteoporosis among both postmenopausal women and treating physicians.[4,5] It is well known that bone mineral density (BMD) assessment by dual-energy X-ray absorptiometry (DXA) is the gold standard in the diagnosis of osteoporosis;[6] the same, however, is not widely available in resource-constrained settings across India.[7] Hence, alternate risk assessment tools are available to identify those at high risk for osteoporosis among postmenopausal women and older men.

Methodology

We did an extensive literature search of publications focusing on screening tools in the diagnosis of osteoporosis. A combination of keywords "osteoporosis," "postmenopausal women," "screening tools," "risk assessment tools," "India," were entered into the PubMed and Google Scholar search engines to retrieve original and review articles written in the English language to prepare this narrative review.

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Screening Tools for Osteoporosis

Screening tools encompasses simple questionnaires assessing a composite of risk factors such as advancing age, high-risk ethnic group, weight, use of glucocorticoids, or hormone replacement therapy to compute the risk of osteoporosis. These tools thus circumvent the disadvantages of high costs and lack of equipment availability to assess the risk of low BMD.[8,9] Some of these tools include the osteoporosis self-assessment tool for asians (OSTA), Osteoporosis Risk Assessment Instrument (ORAI), Simple Calculated Osteoporosis Risk Estimation (SCORE), Age, Bulk, One or Never Estrogen (ABONE), Osteoporosis Prescreening Risk Assessment Instrument and Osteoporosis

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Index of Risk. Male Osteoporosis Risk Estimation Score (MORES) is a screening tool for osteoporosis developed to identify men at risk of osteoporosis. All these tools perform similarly and are moderately accurate in predicting osteoporosis. Fracture Risk Assessment Tools (FRAX) such as FRAX developed at the University of Sheffield, and others, including the Garvan fracture risk calculator and the Qfracture scores, are available for estimating fracture risk.

Development and Validation of Osteoporosis Screening Tools

SCORE was developed in a cohort of 1102 postmenopausal women and used the parameters of race, the presence of rheumatoid arthritis (RA), history of fractures, age, weight, and the use of estrogen therapy.[10,11] ABONE was used in 1610 postmenopausal women and used age, weight, and estrogen therapy.[12] ORAI was more categorical and used age, weight, and estrogen therapy parameters and was first validated in the Canadian multicenter osteoporosis study with 926 women aged more than 45 years.[13] OSTA was developed in 860 postmenopausal Asian women in eight countries (China, Taiwan, Hong Kong, Korea, Malaysia, Singapore, Thailand, and the Philippines). OSTA was calculated as one-fifth of the difference between weight in kilogram and age in years.[14] MORES was developed and validated in 2995 men, ≥50 years old and representative of the general US population, enrolled in the National Health and Nutrition Examination Survey III. Using a weighted scale that includes age, weight, and history of COPD, the MORES identifies men at higher risk of osteoporosis (cutoff ≥6) who should undergo a diagnostic DXA scan.[15] The parameters utilized in these tools and the cutoffs used to identify postmenopausal women at risk for osteoporosis are shown in Tables 1-4.

In a recent study conducted at the authors' center, 2108 ambulatory South Indian rural postmenopausal women were assessed with SCORE, ABONE, ORAI, and OSTA. BMD was estimated by DXA scan at the FN, and sensitivity and specificity were calculated for all tools for predicting FN osteoporosis. Osteoporosis at the femoral neck was seen in 27%. The sensitivities of SCORE, ABONE, OSTA, and ORAI ranged from 81% to 91%, with specificities in the range of 35%–52%. Overall, SCORE performed well with an area under the curve (AUC) of 0.806 in predicting femoral neck osteoporosis.[16] Thus, it was inferred that this tool could be used in resource-limited countries to screen the population at risk and enable treating physicians to make appropriate management decisions. In another study undertaken at the authors' center on 512 men aged 65 years and above, it was found that MORES performed well in predicting osteoporosis at the femoral neck and lumbar spine, with an AUC of 0.760 and 0.885, respectively. OSTA similarly performed well in predicting osteoporosis at the femoral neck and lumbar spine with AUCs of 0.778 and 0.716, respectively.[17] In a similar study done in Northern India on 257 community-dwelling men, OSTA demonstrated an AUC of 0.702 in predicting osteoporosis, and at a cutoff of ≤2, the sensitivity and specificity were 95.7% and 33.6%.[18]

Other Clinical Surrogates in Predicting Osteoporosis

Dentition

Osteoporosis is a systemic skeletal disease and thus may result in weakening the jawbones. A decrease in bone density of the jaw may result in tooth loss due to poor anchoring of the teeth. Therefore, dentition may serve as a clinical surrogate in detecting osteoporosis. In a study on 150 ambulatory postmenopausal women aged more than 50 years, in which the prevalence of osteoporosis was 39%, it was found that among patients with loss of three or more teeth, the odds of having osteoporosis was 4.2 (95% confidence interval: 2.4–7.3).[19]

Anthropometry

Several studies have shown the correlation between anthropometric measures such as weight, waist circumference, hip circumference, and BMD. While

Table 1: Simple calculated osteoporosis risk estimation

Screening tools	Cut off point	Risk factors	Score	Conditions
SCORE	≥6	Race	+5	Woman is not black
		RA	+4	Woman has RA
		History of fractures	+4	For each type (wrist, rib, hip) of nontraumatic fracture after age 45 (maximum=12)
		Age (years)	+3	Times first digit of age in years
		Estrogen therapy	+1	Woman has never received estrogen therapy
		Weight	−1	Times weight in pounds divided by 10 and truncated to nearest integer

SCORE=Race + RA + fracture history + estrogen + (3×age/10) − (weight/10). SCORE: Simple calculated osteoporosis risk estimation, RA: Rheumatoid arthritis

Table 2: Age, Bulk, One or Never Estrogen

Screening tools	Cut off point	Risk factors	Score	Conditions
ABONE	≥2	Age (years) >65	1	
		Weight (kg) <63.5	1	
		Estrogen therapy	1	Woman has never received estrogen therapy

ABONE: Age Bulk One or Never Estrogen

Table 3: Osteoporosis Risk Assessment Instrument

Screening tools	Cut off point	Risk factors	Score	Conditions
ORAI	≥9	Age (years)		
		≥75	15	
		65-74	9	
		55-64	5	
		45-54	0	
		Estrogen therapy	2	Woman has never received estrogen therapy
		Weight (kg)		
		<60	9	
		60-69	3	
		≥70	0	

ORAI: Osteoporosis Risk Assessment Instrument

Table 4: Osteoporosis Screening Tools for Asians

Screening tools	Cutoff point	Risk factors	Score	Conditions
OSTA	≤−1	Age (years) Weight (kg)		0.2×(body weight [kg] − age [years])

OSTA: Osteoporosis Self-Assessment Tool for Asians

these measures may not supersede BMD assessment, they may help screen and identify individuals at risk of compromised bone health, who might then be referred for formal densitometry. In a study on 308 community-dwelling women from rural southern India, it was found that all anthropometric measures showed a positive correlation with BMD. On multivariate logistic regression analysis, it was found that age and weight were the significant predictors of femoral neck osteoporosis, whereas weight and waist circumference were predictive of osteoporosis at the lumbar spine. Thus, a simple anthropometric assessment of women in resource-limited settings might assist in identifying those at risk of osteoporosis.[20]

Urine calcium/creatinine ratio

Previous studies have demonstrated that individuals with osteoporosis have higher urinary calcium levels than those without osteoporosis.[21,22] The same has not been assessed in Indian subjects. As this is test is inexpensive and easily performed, it might be worthwhile exploring this as a screening tool in resource-constrained areas.

Role of Quantitative Ultrasound

DXA is indeed extremely precise in the measurement of BMD. However, some of the disadvantages of DXA are that it is expensive, not widely available, and requires the presence of licensed radiographic technicians to perform the scan. The use of calcaneal ultrasound may overcome these drawbacks. These small and portable machines measure the attenuation and speed of sound passing through the heel bone. One of the advantages of the quantitative ultrasound (QUS) is that it does not use ionizing radiation to assess BMD. This may be used in office-based settings and performed with ease by a nurse or a medical assistant.[23] Although critics have questioned the accuracy of the calcaneal ultrasound,[24] the report derived from the ultrasound may be related to the information gleaned from history and clinical examination to gauge the fracture risk in postmenopausal women.[23] In the study mentioned above, on screening tools in 2108 postmenopausal women, QUS was performed in 850 subjects. At a T-score cutoff of ≤−2.5, the sensitivity and specificity of QUS in predicting femoral neck osteoporosis were 82% and 50%, respectively.[16] This further validates the fact that QUS may be an inexpensive and promising screening tool for osteoporosis in primary care.

Screening Tools for Fracture

FRAX® is an online tool developed at the University of Sheffield as a screening tool to predict the risk of fractures.[25] FRAX® was developed by analyzing different potential risk factors from 60,000 men and women from 12 prospective cohorts recruited from the general population with a total follow-up of 250,000 person-years.[26] The individual risk factors chosen to compute fracture risk include age, BMD, body mass index (BMI), prior fragility fracture, use of oral glucocorticoids, parental history of hip fracture, current smoking, alcohol intake, and RA [Figure 1].

The usage of FRAX® in initiating treatment for osteoporosis varies from country to country. In the US, FRAX is only done in women who have their BMD in the osteopenic range (T score between 1 and 2.5 standard deviation [SD]) and are offered treatment in those with a 10-year probability of major osteoporotic fractures equal to or exceeding 20%, or when the 10-year probability of hip fracture exceeds 3%. As the FRAX tool was validated mostly in cohorts from a Caucasian ethnicity, its use in other countries may require revised cutoffs for therapeutic decision making and follow-up for the occurrence of incident fractures. In another study performed at the authors' center on 301 postmenopausal women, it was found that FRAX with or without the

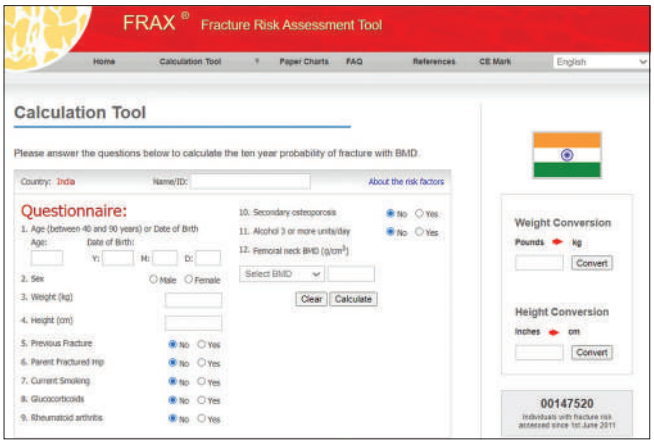

Figure 1: FRAX® - India

incorporation of BMD predicted fragility vertebral fractures at a cut-off of ≥9% for major osteoporotic fracture and ≥2.5% for hip fracture with sensitivities of 77%–88% and specificities of 55%–72%.[27] Other online fracture risk prediction tools include the Garvan fracture risk calculator, which also has a history of falls in calculating fracture risk, and the Qfracture tool, which incorporates, in addition to falls, various chronic systemic diseases as well.[28] However, these tools have not been validated in many countries, including India. The presence of type 2 diabetes mellitus in individuals poses a unique challenge in BMD assessment in that it is noted to be paradoxically high, although the bone quality is compromised.[29] In a study by Leslie *et al*., the four methods used to improve the performance of FRAX in subjects with diabetes mellitus include (a) substitution of RA input to FRAX with diabetes mellitus (b) making a trabecular bone score adjustment to FRAX (c) reducing the femoral neck T-score input to FRAX by 0.5 SD and (d) increasing the age input to FRAX by 10 years. Among these changes, replacing diabetes for RA and increasing the age by 10 years may be a pragmatic approach to improve fracture risk prediction in participants with diabetes, without the need for BMD assessment.[30]

Place of Screening Tools for Osteoporosis in India

The last four decades have witnessed significant progress in the field of bone densitometry. Besides conventional BMD assessment, currently available DXA scanners are equipped with additional software that can report the integrity of the trabecular microarchitecture and macroscopic hip geometry as well. Vertebral fracture assessment may also be performed simultaneously with an assessment of BMD. However, despite the many advances made in this field, the fact remains that India is home to about 140 million postmenopausal women, with more than half of them residing in rural India. The availability of merely 700–800 DXA scanners across the country is grossly inadequate to cater to the large numbers of women who are truly at risk for osteoporosis. Moreover, the prohibitive costs involved may not appeal to the vast majority.

This forms the premise for utilizing various screening tools to identify individuals at risk for osteoporosis and fracture. It must be reinstated that these tools are readily available, inexpensive, easy to perform and may be used in the community and primary care settings. They do not require technical expertise and may be performed by nurses and physician assistants. The validation of various tools in Indian postmenopausal women and older men proves their utility in resource-poor areas. Although these tools do not replace the need for a DXA scan, those identified to be at high risk may be selectively screened by DXA to confirm the diagnosis of osteoporosis and initiate specific treatment. It is imperative to perform a thorough clinical examination and identify other surrogates of bone loss, such as loss of teeth and a low BMI. FRAX may be used even without BMD with altered cutoffs to predict fracture risk.

When writing this narrative review, our country has been ravaged by the COVID-19 pandemic. With the curbs and constraints imposed to curtail the spread of infection, population mobility is largely restricted. Even in tertiary care centers, screening for osteoporosis by DXA has been hit hard by the onslaught of the pandemic. In the given circumstances, health workers may utilize these screening tools to sift out individuals at high risk for osteoporosis and selectively refer them for formal densitometry.

Endorsement of Osteoporosis and Fracture Screening Tools by Clinical Practice Guidelines

The following statements are from the monogram on Clinical Practice Guidelines on Management of Postmenopausal Osteoporosis by the Indian Menopause Society. The book is available from the web portal of the Indian Menopause Society (indianmenopausesociety.org.)

Osteoporotic fracture risk screening of large-scale whole population groups is not likely to be cost-effective, so more selective approaches, i.e., targeted screening for disease detection, are advocated. Early diagnosis in the asymptomatic period is essential to initiate timely interventions in osteoporosis management and thus

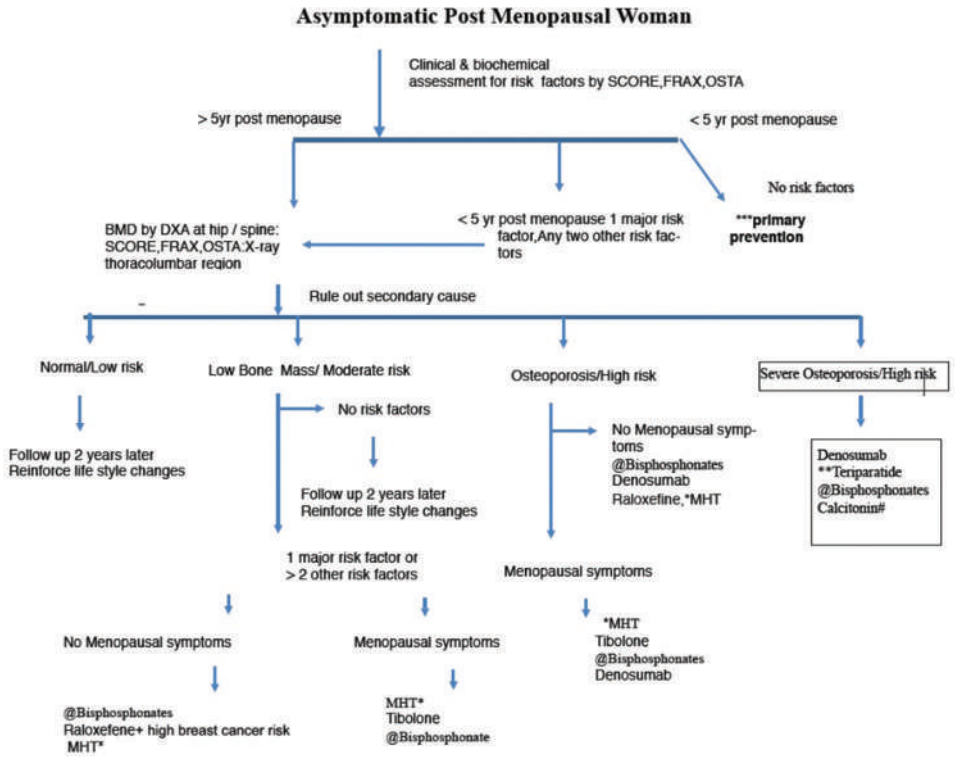

Figure 2: Flowchart for bone health assessment in postmenopausal women. Adapted from Meeta M, et al Clinical practice guidelines on postmenopausal osteoporosis: *An executive summary and recommendations – 2020

prevent associated morbidity and mortality due to osteoporotic fractures. In asymptomatic healthy women above 40 years, opportunistic screening is suggested for osteoporosis (Refer flowchart in Figure 2).[9] Women falling into the risk group of low bone mass or osteoporosis are further evaluated for fracture risk and are individualized with regards to the treatment plan. Risk assessment factors for fractures are derived by history and clinical examination as well as by relevant investigations.

Risk assessment tools such as the Osteoporosis Self-Assessment Tool (OSTA) for Asians and SCORE Score are simple and cost-effective to screen women at risk for osteoporosis. The WHO FRAX is country-specific, and until more Indian data are available on the prevalence of osteoporotic fractures and mortality rates, it may not serve the true purpose in the Indian context. Screening tools pick up those who need a DXA scan. In case of nonavailability of DXA, clinical risk factors and radiography of the lateral thoracolumbar region would help downstage the burden of osteoporosis and provide a lead for those who need long-term treatment to prevent fractures. Numerous studies have documented inadequate osteoporosis preventive care for patients even after they sustain a fragility fracture. For this reason, they can serve as "sentinel" fractures that allow identification of high-risk patients who could benefit from osteoporosis treatment to prevent further vertebral and hip fractures.

The Indian Society for Bone and Mineral Research states that tools like Osteoporosis Self-Assessment Tool for Asians (OSTA) and MORES have been validated for use in the Indian population. These tools are rapid, easy to perform, inexpensive, and possible to use in the rural Indian setting but the impact of initiating therapy based on thresholds derived using these tools is not well studied.[31]

Conclusion

Screening tools are not diagnostic tools, and therefore will never replace BMD assessment by DXA. Notwithstanding, in low- and middle-income countries, where the availability of DXA scanners is limited and unaffordable for many, they may have broader applicability in identifying high-risk individuals.

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Conflicts of interest

There are no conflicts of interest.

References

1. Binu AJ, Cherian KE, Kapoor N, Jebasingh FK, Asha HS, Paul TV. Bone health after fifth decade in rural ambulatory south Indian postmenopausal women. Indian J Community Med 2019;44:205-8.
2. Shetty S, Kapoor N, Naik D, Asha HS, Prabu S, Thomas N, *et al.* Osteoporosis in healthy South Indian males and the influence of life style factors and vitamin d status on bone mineral density. J Osteoporos 2014;2014:723238.
3. Paul TV, Selvan SA, Asha HS, Thomas N, Venkatesh K, Oommen AT, *et al.* Hypovitaminosis D and other risk factors of femoral neck fracture in south Indian postmenopausal women: A Pilot study. J Clin Diagn Res 2015;9:OC19-22.
4. Senthilraja M, Cherian KE, Jebasingh FK, Kapoor N, Paul TV, Asha HS. Osteoporosis knowledge and beliefs among postmenopausal women: A cross-sectional study from a teaching hospital in southern India. J Family Med Prim Care 2019;8:1374-8.
5. Thakur P, Kuriakose C, Cherian KE, Asha HS, Kapoor N, Paul TV. Knowledge gap regarding osteoporosis among medical professionals in southern India. J Eval Clin Pract 2020;26:272-80.
6. Binu AJ, Cherian KE, Kapoor N, Thomas N, Paul TV. Referral pattern for DXA scanning in a tertiary care centre from southern India. Arch Osteoporos 2018;13:133.
7. Varthakavi PK, Joshi AS, Bhagwat NM, Chadha MD. Osteoporosis treatment in India: Call for action. Indian J Endocrinol Metab 2014;18:441-2.
8. Cherian KE, Kapoor N, Paul TV. Commentary on Indian Menopause Society guidelines. J Midlife Health 2020;11:115-6.
9. Meeta M, Harinarayan CV, Marwah R, Sahay R, Kalra S, Babhulkar S. Clinical practice guidelines on postmenopausal osteoporosis: *An executive summary and recommendations – Update 2019-2020. J Midlife Health 2020;11:96-112.
10. Rubin KH, Abrahamsen B, Friis-Holmberg T, Hjelmborg JV, Bech M, Hermann AP, *et al.* Comparison of different screening tools (FRAX®, OST, ORAI, OSIRIS, SCORE and age alone) to identify women with increased risk of fracture. A population-based prospective study. Bone 2013;56:16-22.
11. Lydick E, Cook K, Turpin J, Melton M, Stine R, Byrnes C. Development and validation of a simple questionnaire to facilitate identification of women likely to have low bone density. Am J Manag Care 1998;4:37-48.
12. Weinstein L, Ullery B. Identification of at-risk women for osteoporosis screening. Am J Obstet Gynecol 2000;183:547-9.
13. Cadarette SM, Jaglal SB, Kreiger N, McIsaac WJ, Darlington GA, Tu JV. Development and validation of the Osteoporosis Risk Assessment Instrument to facilitate selection of women for bone densitometry. CMAJ 2000;162:1289-94.
14. Koh LK, Sedrine WB, Torralba TP, Kung A, Fujiwara S, Chan SP, *et al.* A simple tool to identify Asian women at increased risk of osteoporosis. Osteoporos Int 2001;12:699-705.
15. Shepherd AJ, Cass AR, Carlson CA, Ray L. Development and internal validation of the male osteoporosis risk estimation score. Ann Fam Med 2007;5:540-6.
16. Cherian KE, Kapoor N, Shetty S, Naik D, Thomas N, Paul TV. Evaluation of different screening tools for predicting femoral neck osteoporosis in rural south Indian postmenopausal women. J Clin Densitom 2018;21:119-24.
17. Satyaraddi A, Shetty S, Kapoor N, Cherian KE, Naik D, Thomas N, *et al.* Performance of risk assessment tools for predicting osteoporosis in south Indian rural elderly men. Arch Osteoporos 2017;12:35.
18. Bhat KA, Kakaji M, Awasthi A, Kumar K, Mishra K, Shukla M, *et al.* Utility of osteoporosis self-assessment tool as a screening tool for predicting osteoporosis in Indian men. J Clin Densitom 2017;20:160-3.
19. Kapoor N, Cherian KE, Pramanik BK, Govind S, Winford ME, Shetty S, *et al.* Association between dental health and osteoporosis: A study in south Indian postmenopausal women. J Midlife Health 2017;8:159-62.
20. Sridharan K, Cherian KE, Kurian ME, Asha HS, Paul TV, Kapoor N. Utility of anthropometric indicators in predicting osteoporosis in ambulant community dwelling rural postmenopausal women from southern India. Trop Doct 2020;50:228-32.
21. Girón-Prieto MS, Del Carmen Cano-García M, Poyatos-Andújar A, Arias-Santiago S, de Haro-Muñoz T, Arrabal-Martín M, *et al.* The value of hypercalciuria in patients with osteopenia versus osteoporosis. Urolithiasis 2017;45:279-83.
22. El-Husseini A, Chakraborty A, Yuan Q, Inayatullah S, Bush H, Sawaya BP. Urinary calcium excretion and bone turnover in osteoporotic patients. Clin Nephrol 2017;88:239-47.
23. Tonino RP. Ultrasound and alendronate: New tools for osteoporosis screening and treatment. Cleve Clin J Med 1998;65:398-401.
24. Richmond BJ. Enthusiasm for ultrasound for osteoporosis screening is premature. Cleve Clin J Med 1998;65:403-4.
25. Cherian KE, Kapoor N, Paul TV. Utility of FRAX (fracture risk assessment tool) in primary care and family practice setting in India. J Family Med Prim Care 2019;8:1824-7.
26. Kanis JA, Johansson H, Harvey NC, McCloskey EV. A brief history of FRAX. Arch Osteoporos 2018;13:118.
27. Rajan R, Paul J, Cherian KE, Asha HS, Kapoor N, Paul TV. FRAX® with or without BMD and TBS predicts fragility fractures in community-dwelling rural southern Indian postmenopausal women. Arch Osteoporos 2020;15:82.
28. Leslie WD, Lix LM. Comparison between various fracture risk assessment tools. Osteoporos Int 2014;25:1-21.
29. Paul J, Devarapalli V, Johnson JT, Cherian KE, Jebasingh FK, Asha HS, *et al.* Do proximal hip geometry, trabecular microarchitecture, and prevalent vertebral fractures differ in postmenopausal women with type 2 diabetes mellitus? A cross-sectional study from a teaching hospital in southern India. Osteoporos Int 2021;32:1585-93.
30. Leslie WD, Johansson H, McCloskey EV, Harvey NC, Kanis JA, Hans D. Comparison of methods for improving fracture risk assessment in diabetes: The Manitoba BMD Registry. J Bone Miner Res 2018;33:1923-30.
31. Bhadada SK, Chadha M, Sriram U, Pal R, Paul TV, Khadgawat R, *et al.* The Indian Society for Bone and Mineral Research (ISBMR) position statement for the diagnosis and treatment of osteoporosis in adults. Arch Osteoporos 2021;16:102.