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Camp Based Bone Mineral Density Screening as a Tool for Skeletal Health Awareness: A Cross-Sectional Study Using Calcaneal Quantitative Ultrasound.

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Abstract

Background: ***Objective:*** Osteoporosis is defined as a systematic bone disease that is characterized by low bone mass and deterioration of the microarchitecture of the bone, leading to fragility of bone and eventually fractures. In India, osteoporosis is a serious public health issue. However, it might be challenging to diagnose and effectively manage osteoporosis in the Indian context. Data show that osteoporotic fractures happen sooner in age among Indians than in the West; hence, osteoporosis screenings should start sooner. Therefore, we conducted this study to investigate the impact of factors such as social and demographic profile, dietary habits, menstrual status, and physical activity level. And the study also aims to assess awareness about the importance of bone mineral density (BMD) estimation for early diagnosis and treatment of osteopenia/osteoporosis. ***Method:*** A hospital-based camp for screening bone mineral density organized at a tertiary care teaching hospital in New Delhi. We measured BMD using calcaneal quantitative ultrasonography. WHO criteria-based T scores were used to classify patients as normal, osteopenic, and osteoporotic, respectively. ***Result:*** A total of 175 persons attended the camp: 55 males and 120 females. Their ages range from 27 to 77, with a mean age of 51.93. Osteopenia was present in 56 % of the subjects and osteoporosis in 31%. Low BMD was positively correlated with increasing age, postmenopausal status, low dietary calcium intake, and physical inactivity. No significant association was observed with body mass index (BMI) and low BMD. ***Conclusion:*** A camp-based approach helps identify subclinical cases of osteopenia and osteoporosis in the community. It can also help increase awareness of skeletal health, especially in developing countries where a large population cannot afford expensive investigations like BMD estimation using dual X-ray absorptiometry (DEXA) scans.

Keywords: Osteoporosis, Bone Mineral Density (BMD), Calcaneal Quantitative Ultrasound (QUS), Dual-Energy X-ray Absorptiometry (DEXA), Osteopenia.

INTRODUCTION

Osteoporosis is characterized by low bone mass and microarchitectural deterioration of bone tissue, leading to enhanced bone fragility. Osteoporosis is a silent disease, reflected only in low bone density until a fracture occurs.1 With the increasing longevity of the Indian population, it is now being realized that, as in the West, osteoporotic fractures are a major cause of morbidity and mortality.2 During puberty and adolescence, the skeleton takes up calcium avidly and builds up its reserves. This uptake of calcium into the bone largely depends on calcium and vitamin D nutrition, as well as physical activity. Peak bone mass is usually achieved by the age of 30 years. From the mid-thirties, a gradual, progressive bone loss continues throughout life and is accelerated at menopause in women. Therefore, the fracture prevention strategy increases peak bone mass in the growing years and reduces subsequent bone loss throughout life.1,2

Several risk factors contribute to low bone mass. These include non-modifiable factors like female gender, old age, thin build, Caucasian/Asian ethnicity, and family history of fractures. Important modifiable risk factors include calcium and vitamin D deficiency, sedentary lifestyle, smoking, and excessive alcohol and caffeine intake.2,3

Several non-invasive techniques are available for estimating skeletal mass or density. These include Dual X-ray Absorptiometry (DEXA), Single Energy X-ray Absorptiometry (SEXA), Quantitative Computed Tomography (CT), and Ultrasound.

WHO classified osteoporosis based on a DEXA scan of the hip as normal if the T score is -1 or above, low bone mass or osteopenia if the T score is between -1 and -2.5, and osteoporosis if the T score is below -2.5.1 DEXA is the gold standard for measuring bone density; however, the expense of the method makes it difficult to apply to a mass population in the camp-based survey. Calcaneal quantitative ultrasound measurement is portable, easier to handle, radiation-free, cheap, and non-invasive, making it suitable for mass assessment of bone status and fracture risk. 4,5 Few studies reports that fracture risk for the hip and spine increases by two-fold; fracture risk for the hip and spine increases by two-fold for every SD decrease in the calcaneal QUS-measured variable, which is comparable to DEXA.

This study was designed to understand the effect of social and demographic profiles, dietary habits, menstrual status, and physical activity levels of attendees on calcaneal QUS BMD. It also aims to assess awareness about the importance of BMD estimation for early diagnosis and treatment of osteopenia/osteoporosis.

MATERIALS AND METHODS

A hospital-based bone mineral density screening camp was organized at a tertiary care teaching hospital in New Delhi. Written informed consent was obtained from all patients or their legally authorised representatives prior to enrolment. The procedures followed were in accordance with the ethical guidelines of the Indian Council of Medical Research (ICMR) and with the Helsinki Declaration (revised 2000). Institutional Ethics Committee approval was obtained prior to data collection. BMD was measured using calcaneal QUS. WHO standard criteria based on T scores were used to classify patients as normal, osteopenic, and osteoporotic, respectively. The patient's socioeconomic and demographic profile and dietary habits were recorded, along with the history of a chronic medical condition, on a predesigned proforma. The level of physical activity was measured using the General Practice Physical Activity Questionnaire (GPPAQ) for both adulthood and the current age of each participant.

Statistical Analysis: Spearman's rho test was used for nonparametric correlations, and chi-square was used for parametric variables. The Kruskal-Walli's test was used for descriptive analysis.

RESULTS

We measured BMD in 175 individuals of both genders who attended BMD screening camp. Fifty-five were male, and 120 were female. Their ages range from 27 to 77 years, with a mean age of 51.93. Most of the population had one or more risk factors for low BMD. **(Table 1).**

Table 1. Presence of selected risk factors and test results among study subjects.

Risk Factors	Number of people affected
Post-menopausal women	48
Smoking/tobacco	8
Alcohol	6
Physical inactivity	123
Daily calcium intake <300 gm	86
Thyroid disorder	13
Low BMI	7

In our study, osteopenia was present in 98 individuals (56%), osteoporosis in 54 individuals (31%), and normal BMD in 23 individuals (13%). **(Table 2)** In the women population (n=120), 82 were homemakers, of whom 45 (54.9%) were osteopenic and 29 (35.4%) were osteoporotic. Daily calcium intake in 86 (49.1%) was less than 300 gm of calcium per day, 61 (34.85%) were taking 300-500 gm, and 28 (16%) were taking more than 500 gm of calcium per day in their routine diet. In 44 premenopausal women, 6 (13.6%) had normal BMD, 23 (52.3%) were osteopenic, and 15 (34.1%) were osteoporotic, while in peri- and postmenopausal women (n=76), 6 (7.8%) had normal BMD, 42 (55.2%) had osteopenia, and 28 (36.8%) had osteoporosis.

Table 2. Prevalence of Osteopenia/porosis among study subjects

Gender	Normal BMD	Osteopenia	Osteoporosis	Total
Male	11 (20%)	32 (58.2%)	12 (21.8%)	55 (100%)
Female	12 (10%)	66 (55.0%)	42 (35%)	120 (100%)

In our study, the majority of the screened subjects had a BMI ≥ 18.5. In the normal BMI, 69 subjects were screened; 39 (56.5%) were osteopenic, and 17 (24.6%) were osteoporotic. In the overweight and obese population (n=99), 55 (55.5%) were osteopenic, and 35 (35.35%) were osteoporotic. **(Table 3).**

Table 3. BMD classification in relation to BMI

BMI (Body Mass Index)	BMD (Bone Mineral Density)			
	Normal	Osteopenia	Osteoporosis	Total
Under weight (<18.5)	1 (14.3%)	4 (57.1%)	2 (28.6%)	7 (100%)
Normal (18.5-24.9)	13 (18.8%)	39 (56.5%)	17 (24.6%)	69 (100%)
Over weight (25-29.9)	6 (10.3%)	31 (53.4%)	21 (36.2%)	58 (100%)
Obese (>30)	3 (7.3%)	24 (58.5%)	14 (34.1%)	41 (100%)

As measured by the GPPAQ scale, physical activity level was recorded in the whole study population for their current age (n=175). Only 104 people were able to recall their activity level in adulthood. While recording GPPAQ (adulthood) (n=104), 66 (63.46%) people were physically active (active or moderately active on the GPPAQ scale), and 38 (36.53%) were inactive (moderately inactive or inactive on the GPPAQ scale). In the active population (n=66), 9 had normal BMD, 37 (56%) were osteopenic, and 20 (30%) were osteoporotic. While in the inactive population (n=38), 6 had normal BMD, 11 (28%) were osteopenic, and 21 (55.26%) were osteoporotic. **(Table 4).**

Table 4. BMD classification and relation with GPPAQ (adulthood)

GPPAQ (adulthood) (n=104)	BMD			
	Normal	Osteopenia	Osteoporosis	Total
Active	6	20	7	33
Moderately active	3	17	13	33
Moderately inactive	5	9	16	30
Inactive	1	2	5	8

Current physical activity as measured by GPPAQ (n=175): 52 (29.7%) were active (active and moderately active on GPPAQ), and 123 (70.3%) were inactive (moderately inactive and inactive on the GPPAQ scale). **(Table 5)**

Table 5. BMD classification and relation with GPPAQ (current age)

GPPAQ (Current) (n=175)	BMD			
	Normal	Osteopenia	Osteoporosis	Total
Active	7	8	2	17
Moderately active	3	20	12	35
Moderately inactive	5	48	18	71
Inactive	8	22	22	52

DISCUSSION

Increased mortality is closely correlated with osteoporotic fractures. Approximately 20–30% of patients with osteoporotic fractures pass away within 6 months as a result of prolonged immobility and surgical complications. Therefore, it is crucial to be able to recognize osteoporosis and treat it promptly before fractures develop.12 Peak bone mass achieved during puberty is a strong predictor of the development of osteoporosis in later life. 2

Assessment heel quantitative ultrasound (QUS) versus DXA for osteoporosis found heel-QUS predicts fractures independently of FRAX, BMD, and TBS, supporting its use as a pre-screening tool.13 QUS correlated moderately with femoral BMD (and lumbar BMD in women), with high specificity but limited sensitivity, identifying a QUS T-score of –1.8 as the optimal diagnostic cut-off. QUS-DXA correlations were only low-to-modest ($r \approx 0.29–0.44$) with poor diagnostic sensitivity, warning against using DXA thresholds for QUS.14 Overall: heel-QUS is useful for fracture-risk pre-screening but not a reliable stand-alone diagnostic substitute for DXA.15

We conducted a cross-sectional study to evaluate the incidence of osteoporosis among the patients visiting a tertiary care center. We screened 175 attendees for estimating BMD; 55 were male and 120 were female, and their mean age was 51.93 years. The majority of attendees had one or more risk factors for osteoporosis (post-menopausal women, smoking/tobacco, alcohol, physical inactivity, daily calcium intake <300 gm, thyroid disorder, low BMI).

In our study, osteopenia was present in 56 % of the attendees and osteoporosis in 31%. In a camp-based survey, Santosh Mishra et al.6 found that 39.59% of attendees were either osteopenic or porotic, which was lower than in our study. They also noticed a significant association between regular alcohol intake and decreased BMD, which was similar to our study. In another cross-sectional community-based descriptive study by Tripti Agrawal et al.7, the prevalence of osteoporosis was

13.3 ± 5.29%, and osteopenia was 48.1 ± 7.79%, which was lower than in our study. More than 80% of the population in their study above 50 years was either osteoporotic or osteopenic.

In our study of 44 premenopausal women, 52.3% were osteopenic and 34.1% were osteoporotic, while among 76 peri- and postmenopausal women, osteopenia was recorded in 55.2% and osteoporosis in 36.8%. Neelam Aggarwal et al.8, in a study of 200 peri- and postmenopausal women, observed low BMD in more than half (53%) of the study population, similar to our findings. In a population-based observational study done by Suman et al.10, postmenopausal women had significantly less BMD than premenopausal women. In our study, we observed a high prevalence of low BMD in the perimenopausal and postmenopausal age groups. Additionally, we observed a high prevalence of osteopenia/osteoporosis in males. Therefore, further evaluation and treatment are necessary. Most of the osteopenic/porotic women in our study were homemakers. The phenomenon may be attributed to the need for sun exposure and poor dietary habits of homemaker women in India.2

We observed that the daily calcium intake of 49.1% was less than 300 grams per day, 34.85% were taking 300–500 grams per day, and 28.16% were taking more than 500 grams of calcium per day in their routine diet. As per Indian Council of Medical Research (ICMR) recommendations, the dietary intake of calcium was inadequate in the majority of the attendees; similar observations were seen in a study by Neelam Aggarwal et al.8 who reported that 19 % of the population with normal BMD and 37.7% with low BMD had dietary calcium intake below the recommended daily intake. We observed a positive correlation between T score and daily calcium intake. Adequate dietary calcium intake is one of the important risk factors in decreasing the risk of osteoporosis, as reported by Nicola Nepoli et al.9 In their study, they observed that postmenopausal women concluded that a higher calcium intake from a dietary source produces favourable effects on bone health and BMD.

In our study we classified physical activity levels as per the GPPAQ scale to classify and observed that the prevalence of osteopenia and osteoporosis correlated negatively with increasing physical activity levels on the GPPAQ scale. With increasing age, the level of physical activity decreased, and the prevalence of low BMD increased. Similar observations were reported by Neelam Aggarwal et al.8 they reported that 46.8% of women with normal BMD and 33% with low BMD had low physical activity. In a review-based article, Magnus et al.11 concluded that increased physical activity increases the accrual of bone minerals during growth. They also quoted that adequate nutrition must accompany exercise to attain a strong skeleton and physically active lifestyle, and that skeletal mechanical load and adequate nutrition play an essential role in increasing the peak bone mass and, in a longer perspective, possibly reducing the number of fragility fractures.

This study has some limitations; the estimated daily calcium intake was done only with milk and milk products, and only OPD patients who volunteered for BMD estimation were included in the study. So, this study only projects the sample of some of the population.

CONCLUSION

The quantitative ultrasound (QUS) method is a potential screening tool for osteoporosis because of its low cost, feasibility, and portability. A camp-based approach helps identify subclinical cases of osteopenia and osteoporosis in the community. This will also help in increasing awareness of skeletal health, especially in developing countries like India, where a large population cannot afford expensive investigations like BMD estimation.

The camp-based approach has greater participation of women, as their health is often neglected, and it may help to sensitize people about a healthy lifestyle, adequate diet, exercise, sun exposure, etc., that can have a significant positive impact on bone health.

REFERENCES

1. National Osteoporosis Foundation. Clinician's guide to prevention and treatment of osteoporosis. Washington (DC): National Osteoporosis Foundation; 2010.
2. Malhotra N, Mithal A. Osteoporosis in Indians. Indian J Med Res. 2008 Mar;127:263–8.
3. Karlsson MK, Gerdhem P, Ahlborg HG. The prevention of osteoporotic fractures. J Bone Joint Surg Br. 2005;87(10):1320–7.
4. Chin KY, Ima-Nirwana S. Calcaneal quantitative ultrasound as a determinant of bone health status: what properties of bone does it reflect? Int J Med Sci. 2013;10(12):1778–83.
5. Aqilah-SN SMZ, Zulfarina SM, Nazrun AS, Sabarul AM, Isa NM. Quantitative ultrasound scan (QUS) for the assessment of bone health. Med Health. 2014;9(1):1–10.
6. Mishra SK, Trivadi A, Trivedi A. A study of factors leading to osteopenia in the community: BMD camp-based approach. Int J Community Med Public Health. 2015 Aug;2(3):234–6.
7. Agrawal T, Verma AK. Cross sectional study of osteoporosis among women. Med J Armed Forces India. 2013; 69:168–71.

8. Aggarwal N, Raveendren A, Kaur R, Suri V, Suri V, Malhotra N, et al. Prevalence and related risk factors of osteoporosis in peri- and postmenopausal Indian women. J Midlife Health. 2011 Jul-Dec;2(2):81–5.
9. Napoli N, Thompson J, Civitelli R, Armamento-Villareal R. Effects of dietary calcium compared with calcium supplements on estrogen metabolism and bone mineral density. Am J Clin Nutr. 2007; 85:1428–33.
10. Suman VB, Perwez K, Sharma A, et al. Risk factors associated with osteoporosis – A population-based study using p-DEXA technique. Int J Sci Res Publ. 2013 Feb;3(2):1–6.
11. Karlsson MK, Nordqvist A, Karlsson C. Physical activity increases bone mass during growth. Food Nutr Res. 2008;52.
12. Kanis JA, Oden A, Johnell O, De Laet C, Jonsson B, Oglesby AK. The components of excess mortality after hip fracture. Bone 2003;32:468-73.
13. Metrailler A, Hans D, Lamy O, Elena Gonzalez Rodriguez, Enisa Shevroja. Heel quantitative ultrasound (QUS) predicts incident fractures independently of trabecular bone score (TBS), bone mineral density (BMD), and FRAX: the OsteoLaus Study. Osteoporosis international. 2023 May 8;34(8):1401–9.
14. Li C, Sun J, Yu L. Diagnostic value of calcaneal quantitative ultrasound in the evaluation of osteoporosis in middle-aged and elderly patients. Medicine. 2022 Jan 14;101(2):e28325.
15. Swinton PA, Elliott-Sale KJ, Sale C. Comparative analysis of bone outcomes between quantitative ultrasound and dual-energy x-ray absorptiometry from the UK Biobank cohort. Archives of osteoporosis. 2023 May 30;18(1).