Original article:

Status of bone mineral density in adult population using calcaneal ultrasound bone densitometer: A study from Assam, India

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Abstract:

Introduction: Osteoporosis, an important cause of fracture in India is highly unrecognized and un-addressed issue. This condition is characterized by low bone mineral density (BMD) for which screening is not routinely done. Again there is paucity of literatures regarding the prevalence of low BMD among adult population from this part of the country. With growing awareness of the condition and its complication demands special attention to be paid to early detection and treatment. The present study was carried out to study the bone mineral status of adult population in a rural block of Assam and also to find out some of its correlates.

Materials and methods: the study was conducted among the attendants of routine health camps, organized in the block. A total of 93 subjects (60 females and 33 males) were screened by using calcaneal ultrasound heel bone densitometer.

Results & observation: The study reveals that though the prevalence of osteoporosis and osteopenia were more in 50-60 years (85.71%) and > 60 years group (87.5%), high prevalence of osteopenia (68.75%) was also noted in younger 40-50 years group. Low BMD was found to be increasing with age, but it is more so in female than male. Significant association was found between BMD and socio-economic status, nutritional status, type of diet and menopausal status.

Conclusion: This study indicates that adult populations are equally at risk of osteoporosis as the elderly group and should be targeted for preventive interventions to prevent growing increase of the condition and its complications.

Keywords: Calcaneal bone mineral density, osteoporosis, osteopenia, body mass index, socio-economical status

Introduction:

Osteoporosis is a major global public health problem associated with significant morbidity, mortality, and socioeconomic burden.[1] Unfortunately, it is often undiagnosed until a fracture occurs.[2] It is estimated that presently one in three women and one in five men over the age of 5th decade suffer from osteoporosis or osteopenia. Measuring bone mineral density (BMD) is the most important tool in the diagnosis of osteoporosis.[3] Low bone mineral density

is a major risk factor for osteoporosis and its related fractures.[4] In 1994, the World Health Organization defined osteoporosis in terms of bone mineral density and fracture, a T-score ≤ -2.5 and/or a previously fragility fracture.[5] In 2013, sources estimate that 50 million people in India are either osteoporotic or have low bone mass.[6] Dual energy X-ray absorptiometry (DEXA) scan is currently the most widely used tool for both axial and appendicular skeleton, but ultrasound has been described as a most cost-

effective and radiation free safe approach to measure bone density with accuracy in screening test as it is portable.[7] Different sites have been used for estimation of bone mineral density like vertebra, hip and forearm by DEXA, but Quantitative Ultrasound (QUS) of cancellous bone in the heel still remain the commonest modality for measuring bone density. Moreover, QUS screening conclusively confirms or rules out osteoporosis and osteopenia in any population.[7] Various authors from time to time have identified different risk factors for low BMD.[2,8,9,10,11] It is very much crucial to have baseline information on BMD for effective planning and intervention. Because of the lack of facilities for measurement of BMD, very limited study on this issue has been done in this part of the country. Hence, the present study was undertaken to assess BMD using ultrasound bone densitometer and also to find out some correlate associated with it.

Material and Method:

A camp based approach was adopted for screening of BMD. Two free health check- up camps were organized in Kumarikata village of Tamulpur subdivision (block) of Baksa district of Assam in the month of March, 2015. The community was well informed before the camp through the opinion leaders, village headmen etc. The participants above 40 years of both sexes who attended the camps and also willing to participate were enrolled for this study. Individual having systemic disease like renal and hepatic disorders, rheumatic arthritis, and endocrine disorders like diabetes, thyrotoxicosis and those on chronic medication of steroid and hormonal drugs were excluded from the study. Finally, a total of 93 subjects, 60 females and 33 males were included in the study. Written informed consent was taken. Questions on dietary habits, occupation, socio-economic status, menstrual history and history of systemic illness along with use of medication were taken in a predesigned and pretested schedule. In menstrual history only menopausal factor was considered. Body Mass Index (BMI) was calculated for assessment of nutritional status as per WHO guidelines.[12] Height (m) and weight (kg) were measured in light clothing and without shoe using standard apparatus while performing ultrasound bone densitometry. Weight was measured to the nearest 0.1kg on a calibrated beam scale and height was measured to the nearest 0.5cm with a measuring tape. Socioeconomic status (SES) was estimated as per B.G. Prasad classification.[13] BMD was measured in calcaneus (heel bone) using Furuno's CM-200 light ultrasound bone densitometer (Furuno electric Co.LTD, Japan).[14] A single technician performed all QUS measurement to minimize subjective error. BMD values were measured in terms of QUS device specific T-score criteria which is similar to WHO's criteria.[15] T- score is the number of standard deviation relative to the standard speed of sound (SOS) value of the young age group.[14]

- Normal is a T-score of −1.0 or higher
- Osteopenia is defined as between −1.0 and −2.5
- Osteoporosis is defined as −2.5 or lower.

Statistical analysis was done by using InStat software. Chi-square was applied to find the association between the variables. $P < 0.05$ was considered as significant.

Result and observation:

Table 1: BMD status showed as per socio-demographic correlates.

Variable	Osteoporosis		Osteopenia		Normal		Total	Chi Square P- value
	No.	%	No.	%	No.	%		
Age (yrs)								
40-50	Nil	–	33	68.75(57.89)	15	31.25(71.42)	48(51.61)	χ^2=31.18 df=4 p<0.0001
51-60	3	14.29(20)	15	71.42(26.32)	3	14.29(14.29)	21(22.58)	
> 60	12	50(80)	9	37.5(15.79)	3	12.5(14.29)	24(25.81)	
Total	15	(16.13)	57	(61.29)	21	(22.58)	93	
Gender								
Male	Nil	–	15	45.45	18	54.55	33	χ^2=30.9 df=1 p<0.0001
Female	15	25	42	70	3	5	60	
Total	15		57		21		93	
SES								
V	7	22.58(46.67)	22	70.97(38.60)	2	6.45(9.52)	31(33.33)	χ^2=18.23 df=6 p=0.0057
IV	4	14.29(26.67)	19	67.86(33.33)	5	17.86(8.77)	28(30.11)	
III	3	9.09(20)	16	48.48(28.07)	14	42.42(24.56)	33(35.48)	
II	1	100(6.67)	–		–		1(1.08)	
Total	15		57		21		93	

*Numbers within parenthesis denote column wise percentage.

In Table 1, out of the 48 respondents in the age group of 40-50 years, no one was found to have osteoporosis. However, majority (69%) had osteopenia in the said group. In the 51-60 age groups almost 86% had as a whole low bone density, i.e. osteoporosis (14.29%) & osteopenia (71.42%). Prevalence of osteoporosis was found to be significantly more in older age group (> 60 years) in comparison to younger age group. The relation between age and bone mineral status was found to be statistically significant (p < 0.0001). Osteoporosis was not found among males respondents, whereas 25% of the female showed osteoporosis. However, osteopenia was recorded in 45% of male, but female found to have higher prevalence of osteopenia and the relationship between gender and BMD status was found to be statistically significant (p < 0.0001). While assessing socioeconomic status, no participant was found to be in class1. A statistically significant association was observed between socio-economic status and BMD.

Figure 1, showing age & Gender wise trend of BMD of the participants.
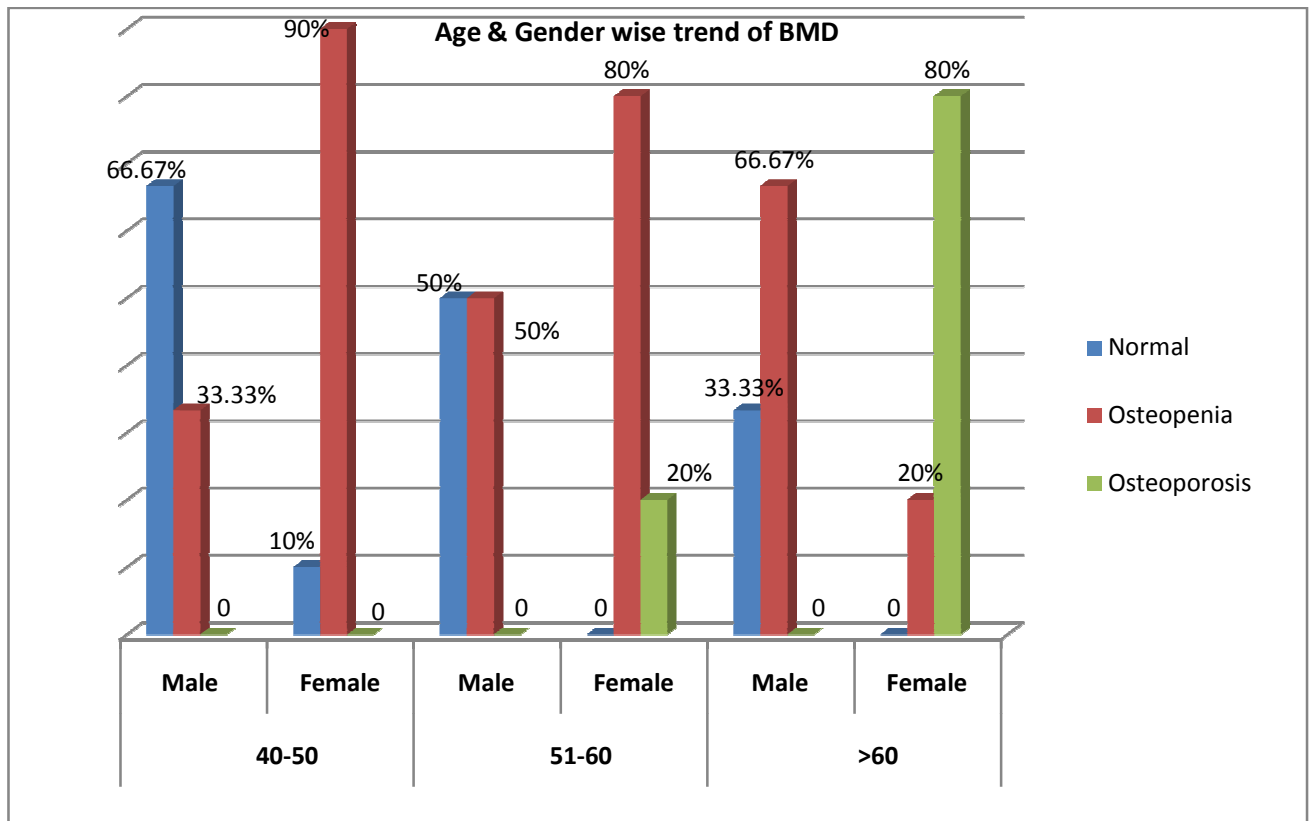
In the Figure 1, while studying the age wise trend of BMD in male and female, it showed that majority (67%) of the males in the 40-50 age group had normal BMD , while only 10% of the female had normal in the same age group. The most significant observation is the higher prevalence (90%) of osteopenia in female in this age group which is quite high in comparison to males (33.33%). Among males, the prevalence of osteopenia was found to be increasing with age, i.e. from 33.33% to 50% in 51-60 age group and 66.67% in the elderly. In female, osteopenia was found to be high in all the age groups. All the females after the age of 50 years were found to have either of osteopenia or osteoporosis.

Table 2: Association of BMD and related risk factors:

Variables	Osteoporosis (n= 15)		Osteopenic (n =57)		Normal (n =21)		Total	Chi square
	No.	%	No.	%	No.	%		p-value
BMI: Undernourished	3	14.29 (20)	18	85.71(31.58)	Nil	–	21 (22.58)	χ^2=14.11 df=4 p=0.0069
Normal	12	20 (80)	33	55 (57.89)	15	25(71.43)	60 (64.52)	
Overweight	Nil	–	6	50 (10.53)	6	50(28.57)	12 (12.90)	
Diet: Veg.	6	33.33 (40)	12	66.67 (21.05)	nil	–	18	χ^2=9.24 df=2 p=0.0098
Non-veg.	9	12 (60)	45	60(78.95)	21	28(100)	75	
Menopausal Status:	(n=15)		(n=42)		(n=3)		(n=60)	χ^2=21.43 df=2 p<0.0001
Pre-	Nil	–	27	64.29 (90)	3	100(10)	30	
Post-	15	100 (50)	15	35.71(50)	Nil	–	30	

*Numbers within parenthesis denote column wise percentage.

In Table 2, we have studied the association of BMD and some of the risk factors like nutritional status (in terms of BMI), diet and menopausal status in females.

All the respondents in under-nourish group had low BMD, either osteopenia (85.71%) or osteoporosis (14.29%).The significant finding is that among the respondents who had normal nutritional status , majority (75%) of them also had low bone density i.e. osteopenia and osteoporosis .Again among the overweight subjects none had osteoporotic changes, but 50% had osteopenia. There was no respondent who falls under obese category in the study population. Statistically significant relation was found between nutritional status and bone mineral density.

The present study observed that all the respondents who had normal BMD were non-vegetarian and all the vegetarian respondents either had some BMD changes, like osteopenia or osteoporosis and it shows a statistically significant association between diet and BMD.

Among the female participants, post menopausal women revealed higher prevalence of low BMD (osteoporosis 50% and osteopenia 50%) than pre menopausal women. Though osteoporosis was not found among premenopausal women, but a high prevalence of osteopenia (90%) have been found. A significant statistical association has been noted between menopausal status and BMD.

Discussion:

This present camp based study was undertaken in health camps in Kumarikata village of Tamulpur sub-division of Baksa district of Assam with the objectives of assessing bone mineral density and to identify some correlate associated with it. The present finding of significant relationship of age with BMD was in conformity with other studies done from time to time.[16,17]. Higher prevalence of low BMD above 50 years and higher age group could lead to more fall, fracture and disability. There is definite scope for more studies regarding prophylactic intervention in this age group. The considerably higher prevalence of osteoporosis and osteopenia found in this study could be viewed as tip of an ice-berg as BMD screening is not routinely done and there is no such recognizable signs and symptoms of low BMD unless the patient turns up with fractures. A database of the issue is crucial which will eventually help in policy formulation for effective interventions.

Female gender, as risk factor for osteoporotic fracture was identified in different literatures.[2,7,11] In a study done in Chennai, 31.8% of women aged 50 years or more were found to be osteoporotic and 36.4% were osteopenic. No male was found to have osteoporotic changes in the present study which was in conformity with study done by M Anburajan & Co-workers. [16] The prevalence of osteopenia (16.7%) in that study was considerably lower than the present finding of osteopenia in males (45.45%). Although low BMD is seen in both elderly male and female, it is more common in elderly women than in men probably due to the fact that women have a smaller bone mass to begin with, and the loss that occurs with aging occurs more rapidly, particularly after menopause removes the bone promoting influence of oestrogen.[18] Estrogen withdrawal enhances osteoclastic activity and suppress osteoblastic activity of the bone.[19]

Although the prevalence of low BMD increases with age in both the sexes, but this is more prominent in females as shown in Figure 1. Females among 40-50 years in osteopenic condition are at risk of developing osteoporosis. There is a scope for preventing further progression of the condition at this age by timely intervention.

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Inadequate nutrition was found to be the reason for high prevalence of osteoporosis and osteopenia in low income group than the prevalence in middle and high income group.[20] In a study done in north India among low-income group, V Shatrugna & Co-worker revealed bone mineral density at all skeletal sites was lower than the value of developed countries Indian people from low-income groups consume diets that have inadequate calcium coupled with too few calories, proteins and micronutrients.[8] Although a statistically significant association was observed between socio-economic status and BMD in the present study, considering the camp base approach in which majority (63.44%) of the attendants belongs to class IV & V, the findings may lack generalizibility. As socioeconomic status of the community determines the nutritional status, this could be the reason for higher prevalence of osteopenia in the present study.

Under nutrition as an important determinant of low BMD status have been found in different literature.[21,22] Statistically significant finding was noted in the present study where nutritional status was classified base on body mass index. Various studies revealed consistent relationship of lower BMI with lower BMD[9,11,23], particularly in postmenopausal women. In men, relationship of low BMI with low BMD was also reported.[24] However, better bone mineral density was observed in overweight and obese postmenopausal female. [10,25] This is thought to be due to mechanical support of fat mass and aromatization of androgens into estrogens in adipose tissue.

While studying the association of diet with bone mineral density, we found that all the respondents attending the camps who were vegetarian had low bone density in relation to the non-vegetarian respondents. Vegetarian diet has been identified as risk factor in studies done across the world.[26,27]. However, the relationship was not consistent in different literatures. Wang & co-workers in their study found no relationship between types of diet with BMD.[28] In another study done in Canada, no significant relationship was found between diet and BMD. The study also revealed a positive association between high energy dense foods and high BMI and also a strong correlation between BMI and BMD.[29] Dietary details in terms of quantity, frequency, type of food consume and duration on present dietary status were not elicited in the present study. In depth studies considering all those factors are crucial in this regard.

The present study observed that majority (90%) of premenopausal women showed osteopenia, i. e. at risk of developing osteoporosis and its consequences, which can be prevented by timely intervention including dietary and nutritional supplementation.[30] The present finding of higher prevalence of osteoporosis and low bone mineral density are consistent with other studies. [2,7,16,21]

Limitation: The major limitations are the camp based approach and smaller sample size.

Conclusion:

The study is first of this kind in north-eastern part of the country for BMD screening in general population. The higher prevalence of low BMD even in middle age (40-50 years) in this study suggests the need for BMD screening and identifying at risk adult population from osteoporotic changes. Further longitudinal study with bigger sample size and with more sensitive methods are recommended at this stage for formulating policy regarding preventive interventions.

Conflict of interest: None declared.

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