

Prediction of bone mineral density by age, body mass index and menopausal status in middle socioeconomic status women of urban Kolar region of Bhopal.

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Abstract: Morbidity and mortality associated with osteoporosis continues to be high in India primarily due to late diagnosis. This study aims to find association of age, body mass index (BMI) and menopausal status with bone mineral density (BMD); and confirm if these variables are predictors of low BMD in premenopausal and postmenopausal women. This cross sectional study was conducted on 350 women aged 30–65 years. BMD was measured at calcaneum heel by Quantitative Ultrasound. Chi-square test and logistic regression have been used for statistical confirmations. Low BMD was found in 51.1% premenopausal and 77.1% postmenopausal women. Age, BMI and menopausal status were found to be associated with BMD. Advancing age, normal BMI and postmenopausal status were predictors of low BMD. Low BMD was more likely to develop in premenopausal women aged 40-59 years (adjusted odds ratio [OR]=2.0;95% confidence interval [95%CI]:1.0-4.2) and in postmenopausal women aged 60 years and above (OR=2.8;95%CI:0.93-8.3); less likely to develop in premenopausal obese women (OR=0.17;95% CI:0.06-0.49) and in postmenopausal obese women (OR=0.04;95%CI:0.005-0.31). Low BMD was more likely to develop in postmenopausal women (OR=2.0;95%CI:1.14-3.55) as compared to premenopausal women. Our study shows that high BMI has protective effect against bone loss. Older women with normal BMI need to be identified at an early stage for taking timely preventive measures to reduce morbidity, mortality and socioeconomic burden associated with osteoporosis.

Keywords: Body mass index, Bone mineral density, Osteopenia, Osteoporosis

I. Introduction

Osteoporosis is a skeletal disorder characterized by low bone strength that leads to an increased risk of fragility fractures. It is a major public health problem across the world that causes considerable morbidity, mortality, and socioeconomic burden. [1] This silently progressing metabolic bone disease is widely prevalent in Indian women and experts peg the number of osteoporosis patients in India at approximately 26 million, with the numbers expected to rise to 36 million by 2013.[2]

Osteoporosis is a condition that can be prevented and treated if diagnosed early and accurately. Unfortunately, it often goes undiagnosed until a fracture occurs. Further proliferation of disease can be checked by increasing screening of people for early signs of osteoporosis. Dual X-ray absorptiometry (DEXA) is a successful way to assess bone mineral density but it often falls out of the affordability range of common man.[3] Modern day non invasive techniques like bone mass measurement, which are cheaper and easier, come handy in diagnosis and management of osteoporosis. Another set of techniques--Quantitative ultrasound method (QUS) introduced recently for the assessment of skeletal status in osteoporosis, is a mobile and radiation free diagnostic alternative to DEXA. [4] It has been found to have a good predictive power of the same order as that of DEXA. [5,6] QUS scanning of the calcaneus is extensively used to find BMD in developing countries due to its low cost. Rapid bone loss is commonly seen in elderly individuals and tends to worsen with advancing age.[7] BMD of women decreases with age, indicating bone loss with age and menopause.[8] Therefore, in view of age and menopause being the primary risk factors of low BMD, it is essential to diagnose it early for giving preventive treatment.[9]

There are several clinical guidelines based on measurement of BMD that recommend risk factor assessment to identify individuals with high risk of osteoporosis.[10] Body weight has been found to be positively associated with BMD, from childhood through adulthood. This relationship is known to be stronger in older women.[11] While the risk factors have been comprehensively characterized in postmenopausal women, the predictive value of body weight and BMI in premenopausal women is still not scientifically verified. [12] This study is aimed to fill this gap and scientifically explore – association of age, BMI and menopausal status with BMD; and to confirm if these variables are predictors of low BMD in premenopausal and postmenopausal women so that timely measures can be taken for prevention and treatment of disease.

II. Material And Methods

This was a hospital based cross-sectional study conducted on women aged 30-65 years of middle socioeconomic status of urban Kolar region of Bhopal visiting various outpatient departments of the J.K. Hospital as an attendant. WHO estimates of 33% for prevalence of osteoporosis among the females in India was taken as reference for arriving at the projected sample size. Assuming a prevalence of 33% and absolute precision of 5% with 95% confidence, the required sample size was estimated to be 350. Age group of 30-65 years was selected to cover both premenopausal and postmenopausal groups. The approvals of the Institutional Ethical Committee were obtained prior to conducting the research. Subjects were included in the study after obtaining their informed consent in local vernacular.

Demographic details on educational level, income, occupation, diet, exercising schedule; and medical, obstetrical, menstrual, and drug history were collected using a structured questionnaire. In addition, information on past non traumatic fracture, family history of fracture and osteoporosis was also obtained. To ensure capturing of variation in BMD only on account of age, BMI and menopausal status, and not due to other factors, uniformity in subject profile was ensured by selecting women from middle socioeconomic status, exposed to similar levels of exercising with similar dietary pattern.

Women in pregnancy, lactating, or in postpartum period less than 12 months, carrying any disease or receiving treatment that could affect BMD; receiving/having received any treatment for osteoporosis; having a secondary cause for osteoporosis; suffering from chronic diseases affecting bone; having endocrinopathies; undergoing current or had past treatment with glucocorticosteroids/thyroid hormones/hormone replacement therapy and those using oral contraceptive pills were excluded from the studies.

Women in sample, were categorized into two groups- premenopausal and postmenopausal. Menopausal criteria considered was absence of menses for at least 12 months. Subjects were screened for Bone Mineral Density at calcaneum heel by means of Quantitative Ultrasound. Observed BMD values were used as T-scores to categorize subjects as normal (T-score ≥ -1.0), osteopenic (T-score between -1.0 and -2.5) or osteoporotic (T-score ≤ -2.5). [13] Height and weight were measured by wall-mounted stadiometer. BMI was calculated using formula- $BMI (kg/m^2) = \text{Weight (in kg)} / \text{Height}^2 (\text{in meter})$. [14] Eight subjects were found to have $BMI < 18.5 kg/m^2$ but because they also fell in one or the other exclusion criteria, so they were excluded from the study. Hence, on the basis of BMI women were categorized as – normal (BMI 18.5-24.9), overweight (BMI 25.0-29.9) and obese (BMI ≥ 30.0).

The data obtained was analyzed using SPSS 16 software. The statistical tests used were chi-square test and logistic regression. The variables considered were age, BMI and menopausal status. The difference between the subjects was considered significant if the P value was less than 0.05.

III. Results

The mean and standard deviation of age in the selected sample was 48.5 ± 11.3 years. Subjects were classified into three broad age groups, 30-39 years, 40-59 years and 60 years and above. Based on the observed values of BMD, the subjects were categorized into two groups for further analysis – normal and low BMD. Low BMD category included women having osteopenia and osteoporosis. None of the females in the age group 30-39 years had osteoporosis and maximum number of osteoporotic females belonged to age group of 60 years and above. Key findings of the study are given in Table 1. BMI was found to be significantly associated ($P < .001$) with BMD in both premenopausal and postmenopausal women, while age was found to be significantly associated ($P < .01$) with BMD in postmenopausal women but not in premenopausal women. [Table 2]

These three variables- age, BMI and menopausal status were put into a binary logistic regression model to find the crude and adjusted Odds Ratio (OR). In premenopausal women, after adjusting for BMI and menopausal status the chance of getting low BMD was 2.0 (CI 1.0-4.2) times higher in females aged 40-59 years, though it was insignificant ($P > .05$) compared to females in the age group 30-39 years. After adjusting for age and menopausal status the chance of getting low BMD was 51% less in overweight females ($P > .05$) and 83% less in obese females ($P < .001$) compared to females with normal BMI.

In postmenopausal women, after adjusting for BMI and menopausal status the chance of getting low BMD was 2.8 (CI 0.93-8.3) times higher in females aged 60 years and above ($P < .05$) compared to females in the age group 40-59 years. After adjusting for age and menopausal status the chance of getting low BMD was 74% less in overweight females ($P > .05$) and 96% less in obese females ($P < .05$) compared to females with normal BMI. [Table 3] After adjusting for age and BMI the chance of getting low BMD was 2 (CI 1.1-3.5) times more in postmenopausal women compared to premenopausal women ($P < .05$). [Table 4]

Table 1
Key findings in premenopausal and postmenopausal women

	Premenopausal	Postmenopausal
Mean age of women	44.6 +/- 7.7	54.4 +/- 7.0
Mean BMI of women	29.3 +/- 3.7	27.8 +/- 3.4
Women in 40-59 years age group	73%	69%
Women with Normal BMD	49%	23%
Women with Low BMD	51%	77%
Women with Normal BMI	13%	24%
Overweight women	24%	31%
Obese women	63%	45%

Table 2
Association of age and BMI with bone mineral density in premenopausal and postmenopausal women

Independent factors		Normal BMD		Low BMD				Total	P
		No.	%	Osteopenia		Osteoporosis			
				No.	%	No.	%		
PREMENOPAUSAL WOMEN									
Age	30-39	28	58.3	20	41.7	-	-	48	>.05
	40-59	60	45.5	36	27.3	36	27.3	132	
BMI	Normal	5	33.3	10	66.7	-	-	15	<.001
	Overweight	15	26.8	12	21.4	29	51.8	56	
	Obese	68	62.4	34	31.2	7	6.4	109	
	Total	88	48.9	56	31.1	36	20	180	
POSTMENOPAUSAL WOMEN									
Age	40-59	34	28.8	63	53.4	21	17.8	118	<.01
	≥60	5	9.6	11	21.2	36	69.2	52	
BMI	Normal	1	2.4	15	36.6	25	61	41	<.001
	Overweight	5	9.4	31	58.5	17	32.1	53	
	Obese	33	43.4	28	36.8	15	19.7	76	
	Total	39	22.9	74	43.5	57	33.5	170	

Table 3
Odds ratio of age and BMI in premenopausal and postmenopausal women

Independent factors		Crude			Adjusted		
		OR	CI	P	OR	CI	P
PREMENOPAUSAL WOMEN							
Age	30-39	1	-		1	-	
	40-59	1.7	0.86-3.3	>.05	2.0	1.0-4.2	<.05
BMI	Normal	1	-		1	-	
	Overweight	0.52	0.16-1.7	>.05	0.49	0.15-1.6	>.05
	Obese	0.19	0.06-0.54	<.01	0.17	0.06-0.49	<.001
POSTMENOPAUSAL WOMEN							
Age	40-59	1	-		1	-	
	≥60	3.8	1.4-10.4	<.01	2.8	0.93-8.3	<.05
BMI	Normal	1	-		1	-	
	Overweight	0.24	0.03-2.1	>.05	0.26	0.03-2.3	>.05
	Obese	0.03	0.004-0.25	<.001	0.04	0.005-0.31	<.05

Table 4
Odds ratio of menopausal status in premenopausal and postmenopausal women

Independent factor Menopausal status	Crude			Adjusted		
	OR	CI	P	OR	CI	P
Pre menopause	1	-		1	-	
Post menopause	3.2	2.02-5.10	<.001	2.0	1.14-3.55	<.05

IV. Discussion

Our study reports that 37% of females had normal T-score while another Indian study reported it to be 29%. [15] The findings of our study corroborate with those of earlier studies that as age advances, the incidence of low BMD increases. [10,16,17] In our study none of the women were found to be osteoporotic before 40 years of age [18,19] though large number were osteopenic. [20] But the incidence of osteoporosis increased in the age group 40-59 years, suggesting a window of opportunity for preventive measures in the third decade of life to check the conversion of osteopenia to osteoporosis. [12]

From findings of this study, it is evident that as BMI increases incidence of low BMD decreases. Earlier studies found high correlation of BMD with BMI [21] and an increase in BMD with an increase in BMI. [12,22] In our study among obese females the chances of getting low BMD was 89% less compared to females with normal BMI whereas a similar Indian study could not find any relationship between obesity and BMD. [23] Thus, overweight may protect women against bone loss after menopause. This protective effect appears to be related to both mechanical support and increased estrogen synthesis in adipose tissue. [24] Thus, BMI has an effect on BMD and BMI can prevent bone loss by increasing the BMD.

Our study reports that 51.1% of premenopausal women had low BMD while the figure was 77.1% in case of postmenopausal women [25] Postmenopausal women were found to have two times more chance of getting low BMD as compared to premenopausal women. [26,27] An increased risk of low BMD (osteopenia and osteoporosis) is associated with age and menopausal status. [28] Declining ovarian function before menopause is accompanied by reduction in bone mass and altered calcium metabolism. [29]

This study is an attempt to address one of the important public health problems which can be controlled if preventive measures are taken at an early stage. Effect of other risk factors could not be investigated as this is a cross-sectional study and uniformity of sample on related parameters is desired to assess the effect of considered variables. In this study low BMD was observed in elderly women, while it is quite possible that the subjects had low BMD since young age. This is one of the limitations of this study as we are interpreting cross sectional data in longitudinal terms. Longitudinal studies over longer periods on women may be conducted in future to overcome this limitation. Future studies may be conducted on premenopausal women with normal BMD to investigate the effect of other factors like exposure to sunlight, calcium intake, and other habits like smoking, diet, and so forth.

V. Conclusion

The results of this study suggest that advancing age, normal BMI and postmenopausal status are significant predictors of low BMD. Our study shows that in women having high BMI, incidence of low BMD is less i.e. high BMI has protective effect against bone loss. To check further proliferation of disease it is essential to create awareness among Indian women about the risk factors of osteoporosis and educate them on possible preventive measures. There is also a need to identify high risk women at an early stage so that early interventions can be instituted. This will reduce morbidity, mortality and socioeconomic burden associated with osteoporosis.

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