International Journal of Public Health Science (IJPHS)
Vol.3, No.4, December 2014, pp. 276 ~ 280
ISSN: 2252-8806

Body Mass Index as Predictor of Bone Mineral Density in Postmenopausal Women in India

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Article Info

Article history:

Received Sept 30, 2014
Revised Oct 25, 2014
Accepted Nov 25, 2014

Keyword:

Body mass index
Body weight
Bone mineral density
Osteoporosis
Postmenopausal women

ABSTRACT

Risk factors for the prediction of osteoporosis are an important and cost effective method since osteoporosis is a silent disease. The purpose of the study was to evaluate the associations between weight, body mass index (BMI), the Osteoporosis Self-Assessment Tool (OST), and bone mineral density (BMD) in postmenopausal women in India. In this cross sectional study, 90 postmenopausal women aged 45–85 years who had given consent participated and the study was conducted between April, 2012 to May, 2013. BMD was measured by ultrasound bone densitometry at calcaneal site. Linear regression multivariate models were used to examine the associations with weight, BMI, OST, and BMD. Body weight, BMI, and OST had almost similar overall performance in their ability to classify women with BMD T-score ≤−2.5. Regression results showed that the linear combination of three independent variables BMI, OST and body weight. BMI predicted 65.7% of the variance in BMD, R^2 = .657, R^2 adjusted = .609, (F=21.295, p<.000). The strongest predictor of low BMD was BMI. BMI showed significant association with BMD with a correlation of .846. Low weight and BMI predict osteoporosis and are associated with increased risks in postmenopausal women. The negative impact of low body weight on bone health should be more widely recognized.

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1. INTRODUCTION

Osteoporosis is characterized by low bone mass and micro-architectural deterioration of bone tissue with an increased risk of fracture and mortality [1]. Fractures are most commonly associated with osteoporosis like those of the hip, the vertebrae, and the wrist, and these are responsible for morbidity and excess mortality. Risk factors have been extensively characterized in women over the age of 50 years and are used in practice, often in combination, to predict fractures [2]-[5]. Low weight and low BMI are also related to an increased fracture risk. Low body mass index (BMI) is a well-documented risk factor for future fractures. The aim of this study was to quantify this pharmacological effect and to explore the association of BMI with fracture risk in relation to age, weight and bone mineral density. In a large meta-analysis of 12 prospective population-based cohorts documented that the age-adjusted risk of a hip fracture was increased 2-fold in older individuals with a BMI of 20 kg/m^2 compared with a BMI of 25 kg/m^2 [6]. The existence of a positive association between body size and bone mass is well established.[7],[8] Moreover, low body mass index (BMI) has been shown to be a predictor of increased bone loss at the forearm.[6] However, the association at other skeletal regions between BMI, bone mass, and bone loss remains to be determined. The potential impact of thinness on the development of postmenopausal osteoporosis is particularly relevant because of the high incidence of malnutrition in the developing countries and because slimness is promoted

as the ideal in industrialized countries. The purpose of this study was to investigate the associations between body weight, BMI, OST, BMD and subsequent fracture risks in postmenopausal women aged 45 to 85 years to guide clinicians in the evaluation of fracture risk in this population. We conclude that low BMI confers a risk of substantial importance for all fractures that is largely independent of age and sex, but dependent on BMD. The significance of BMI as a risk factor varies according to the level of BMI. Its validation on an international basis permits the use of this risk factor in case-finding strategies.

2. MATERIALS AND METHODS

Approval for this cross sectional study was granted from the University Institutional Review Board of Visva-Bharati University. Participants a total of 90 community-dwelling osteoporotic females between the ages of 45 and 85 years met the inclusion criteria and were enrolled in this study. After completion of informed consent, all participants completed a series of one-time measurements including anthropometric, medications, life style factors and bone mineral density.

BMD Assessment

The calcaneal heel site was used for all BMD assessments. Individual participant age, race, height, and weight were entered into the densitometer, and BMD measurement was completed in approximately 5 s. All participants were given a copy of their BMD report, a brief interpretation of their scores, information regarding osteoporosis, healthy foods that provide significant amounts of vitamin D and calcium, and contact information regarding medical follow-up at their own discretion.

Osteoporosis Self-Assessment Tool

Because BMD measurements are not widely available in certain communities, several risk assessment tools have been developed to target women at higher risk of osteoporosis for BMD testing [9]. The Osteoporosis Self-Assessment Tool (OST) uses self-reported data and is derived by score = 0.2 × (weight in kg − age), truncated to an integer with a lower score, identifying women at higher risk of osteoporosis at the femoral neck [10]. OST has been reported to have a sensitivity of 89.2% and a specificity of 45.0% (using a cut-off point of ≤1) for identifying osteoporosis in postmenopausal women aged 45 to 64 years [11].

Statistical Analysis:

Statistics were calculated with SPSS (version 18.0 for Windows; IBM SPSS Inc). An alpha level of $p < .05$ was used to determine significance. Descriptive statistics were used to analyze characteristics of the participants. A regression analysis was used to explore the relationships between BMD and risk factors for osteoporosis (Age, BMI, OST, and FRAX).

3. RESULTS AND DISCUSSION

We identified 90 postmenopausal women aged 45 to 85 years who fulfilled the study criteria. The mean age and weight of the study were 59.54 (SD 11.38) years and 58.84 (SD 11.09) kg respectively. Participant's baseline characteristics were given in Table 1.

Table 1. Participant's Demographic Characteristics

Variables	M ± SD	SE
Age in years	59.54±11.38	1.32
Height in meter	1.51±0.05	0.00
Weight in Kg.	58.84±11.09	1.28
BMI in Kg/m^2	25.54±4.58	0.53
BMD T-score	-3.01±1.08	0.12
OST	-0.13±3.64	0.42
FRAX	24.51±20.52	2.38

M= Mean, SD= Standard Deviation, SE= Standard Error, BMI= Body Mass Index, BMD= Bone Mineral density, OST= Osteoporosis Self-Assessment Tool, FRAX= Fracture Risk Assessment Tool.

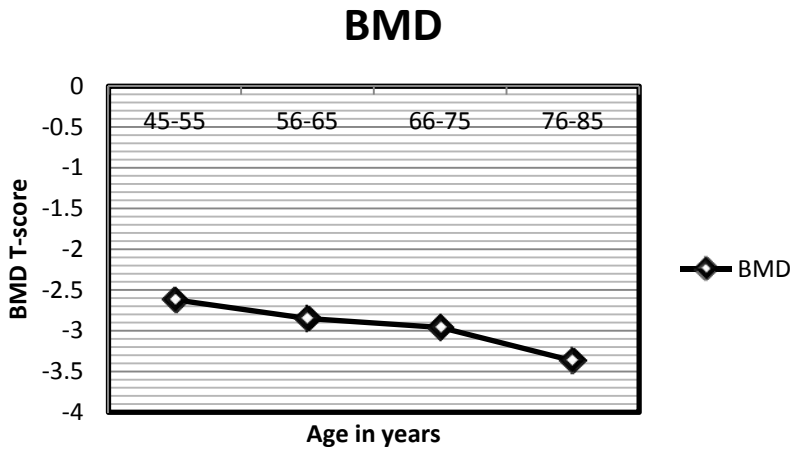

Figure 1. Age-wise variations in Bone Mineral Density at calcaneal site

Figure 1 showed the bone mineral density according to the various age categories of postmenopausal women who are osteoporotic. It can be clearly observed that with increased age the bone mineral density decreased in linear fashion in the elderly women.

Stepwise Multiple Regression Prediction of BMD

Results of step-wise multiple regression analysis for anthropometric variables (age, body height, weight, BMI, OST and FRAX score), best predict bone mineral density (BMD) in elderly women are shown in Table 2.

Table 2. Multiple regression analysis to predict BMD

Model	Variables Entered	Variables Removed	R	R Square	Adjusted R Square
1	BMI	-	.846	.657	.609
2	Weight	-	.769	.542	.530
3	OST	-	.684	.516	.476

Abbreviations: BMI= Body mass index, OST= Osteoporosis Self-Assessment Tool

From all the variables, entered into the equation using stepwise multiple regression analysis, BMD as dependent, following results were obtained. Out of 6 variables entered into equation, 3 variables best predicted the BMD. The first and foremost variable to predict Bone Mineral Density (BMD) was BMI with the correlation coefficient of R= .846 with the contribution of 65.7% (F=21.295, p<.000). Thereafter other variables Weight 54.2% (F=31.26, p<.000), OST 51.6% (F=52.296, p<.000) were predicted the Bone Mineral Density (BMD), respectively. Other variables did not predict the Bone Mineral Density (BMD) in elderly men and women. Since the F-value for this regression model is highly significant and therefore it may be interpreted that all the three variables selected in the model are quite valid in estimating the bone mineral density of elderly population.

Discussions

Women at high risks of osteoporotic fractures can be examined in clinical practices with specific treatment interventions. Women with risk factors such as low body weight and BMI may also be at higher risk of fractures. The results from our study support the previously documented associations between weight, BMI, and BMD. Body weight has been identified in previous reports as a predictor of peak bone mass in pre-menopausal women and a predictor of BMD in older women [12]. It has shown that osteoporosis, as defined by a T-score of ≤ −2.5 at the femoral neck or a T-score ≤ −2.5 at any site is associated with weight, BMI, and OST in the entire study. A BMI of 25 kg/m^2 has been identified as the reference point below which the risk of hip and any osteoporotic fracture starts to increase [6]. Similar conclusions were reached in the Study of Osteoporotic Fractures using a BMI of 26.2 kg/m^2. [5] OST of >1 has traditionally been used to determine low risk designation in post-menopausal women [13]. A potential drawback is that BMI can be influenced by

the height loss associated with vertebral deformities. Therefore, in individuals with important height loss, the risk conferred through BMI on fracture risk could be underestimated. These findings have important consequences for case finding strategies based on clinical risk factors. Leanness should be regarded as a significant risk factor. Secondly, the use of low BMI as a risk factor will identify populations with a low BMD and hence a high risk of fracture. The finding that leanness is much more important as a risk factor for fracture—than obesity is a protective factor—means that advice concerning body weight and osteoporosis need not be inconsistent with the weight control advocated for the prevention of cardiovascular disease or diabetes. The findings are in close agreement with a recent report from the Study of Osteoporotic Fractures that compared several fracture risk assessment tools (including OST) to identify low hip and lumbar spine BMD in 7,779 US women aged 67 years and older. An important finding of this study is the association between lower weight or BMI and an increased risk of osteoporosis-related fractures in this population. With each standard deviation decrease in weight or in BMI, the age-adjusted risk for fractures increased by approximately 19%. Results were comparable with OST. It is difficult to show an independent effect of weight or BMI on the risk of osteoporotic fractures after integration of BMD into the models. Similar conclusions found in a meta-analysis in which the age-adjusted risk for any fracture increased with lower BMI; after adjusting for BMD, BMI was not found to be predictive of fracture risk except for hip fracture [6]. This suggests that BMD may be an important intermediate in the overall strategy.

4. CONCLUSION

In multivariate analysis, BMI and weight were found to be associated with fracture risk independent of prevalent fracture. In this group of females, BMD was primarily influenced by age, weight and BMI. We conclude that low BMI confers a risk of fracture of substantial importance that is largely independent of sex. The significance of BMI as a risk factor varies according to the level of BMI and to a lesser extent on age. It can be concluded that the measurement of simple clinical variables such as age, height, and weight (or BMI) in areas where BMD testing is not readily accessible or limited facilitates the identification of middle-aged and elderly women at risk of osteoporosis and related fractures. The negative impact of low body weight on bone health should be more widely investigated.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research and/or authorship of this article.

ACKNOWLEDGEMENTS

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

REFERENCES

[1] Sambrook P., Cooper C., "Osteoporosis", *Lancet,* vol/issue: 36(7), pp. 2010–2018, 2006.
[2] Cummings SR., Nevitt MC., Browner WS., Stone K., Fox KM., Ensrud KE., "Risk factors for hip fracture in white women. Study of Osteoporotic Fractures Research Group", *N Engl J Med*, vol/issue: 33(2), pp. 767–73, 1995.
[3] Van Staa TP., Leufkens HG., Abenhaim L., Zhang B., Cooper C., "Use of oral corticosteroids and risk of fractures", *J Bone Miner Res*, vol/issue: 15(4), pp. 993–1000, 2000.
[4] Kanis JA., Borgstrom F., De Laet C., Johansson H., Johnell O., Jonsson B., "Assessment of fracture risk", *Osteoporos Int*, vol/issue: 16(3), pp.581–89, 2005.
[5] Kanis JA., Oden A., Johnell O., Johansson H., De Laet C., Brown J., "The use of clinical risk factors enhances the performance of BMD in the prediction of hip and osteoporotic fractures in men and women", *Osteoporos Int*, vol/issue: 18(6), pp. 1033–1046, 2007.
[6] De Laet C., Kanis JA., Oden A., Johanson H., Johnell O., Delmas P., "Body mass index as a predictor of fracture risk: a meta-analysis*," Osteoporos Int*, vol/issue: 16(2), pp. 1330–1338, 2005.
[7] Reid IR., "Relationships among body mass, its components and bone", *Bone*, vol/issue: 3(1), pp. 547–555, 2002.
[8] Felson DT., Zhang Y., Hannan MT., Anderson JJ., "Effects of weight and body mass index on bone mineral density in men and women: the Framingham study", *J Bone Miner Res*, vol/issue: 8(5), pp. 567–573, 1993.

[9] Cadarette SM., Jaglal SB., Murray TM., McIsaac WJ., Joseph L., Brown JP., "Evaluation of decision rules for referring women for bone densitometry by dual-energy x-ray absorptiometry", *JAMA*, vol/issue: 28(6), pp. 57–63, 2001.
[10] Koh LK., Sedrine WB., Torralba TP., Kung A., Fujiwara S., Chan SP., "A simple tool to identify Asian women at increased risk of osteoporosis", *Osteoporos Int*, vol/issue: 12(3), pp. 699–705, 2001.
[11] Gourlay ML., Miller WC., Richy F., Garrett JM., Hanson LC., Reginster JY., "Performance of osteoporosis risk assessment tools in postmenopausal women aged 45–64 years", *Osteoporos Int,* vol/issue: 16(2), pp. 921–927, 2005.
[12] Hawker GA., Jamal SA., Ridout R., Chase C., "A clinical prediction rule to identify premenopausal women with low bone mass", *Osteoporos Int*, vol/issue: 13(4), pp. 400–406, 2002.
[13] Rud B., Hilden J., Hyldstrup L., Hrobjartsson A., "Performance of the Osteoporosis Self-Assessment Tool in ruling out low bone mineral density in postmenopausal women: a systematic review", *Osteoporos Int,* vol/issue: 18(1), pp. 1177–1187, 2007.

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