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Association between Body Mass Index and Bone Mineral Density among healthy women in India

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ABSTRACT

Obesity and osteoporosis are two important and developing public health problems worldwide. Most studies to date on risk factors for osteoporosis have considered body mass index (BMI) only as a possible confounder. In this study, we assess the direct relationship between BMI and osteoporosis. Osteoporosis remains under-diagnosed, particularly in south Gujarat women, despite the availability of reliable diagnostic tests. In women, several screening tools, including heel ultrasound and clinical assessment tools, reliably predict low bone mass. The aim of this study was to determine relationship between body mass index (BMI) and Bone Mineral density (BMD) in healthy young women of south Gujarat. We conducted a cross-sectional study among women aged 25-60 years referred by their physicians for a bone mineral density (BMD) examination at health centre in South Gujarat between January 2016 and February 2016. BMI was determined prior to the BMD examination in the clinic. Information on other risk factors was obtained through a questionnaire. Bone mineral density (BMD) of the heel was measured by heel ultrasound. 273 women fulfilled the inclusion criteria for this study. BMI was inversely associated with BMD status. The population prevalence of osteopenia and osteoporosis were 72% and 67%, respectively. Using a heel ultrasound T-score cut-off value of -1 or less, we predicted low bone mass (T-score of -2 or less at the heel). Women with low BMI are at increased risk of osteoporosis. To help reduce the risk of osteoporosis, patients should be advised to maintain a normal weight. The study demonstrated that numerous factors, both modifiable and non-modifiable, were significantly related to the prevalence of osteoporosis. The modifiable factors identified were participation in physical activity (three to five times per week) and body mass index (BMI). Non-modifiable factors included age. Low body-mass index, low calcium intake, current cigarette smoking, and physical inactivity were independent risk factors identified from population-based studies. The presence of one or more risk factors was associated with having osteoporosis and low BMD in all groups. The strength of these associations was greater when two or more risk factors were present but varied with race/ethnicity, gender, and age. The prevalence of osteopenia and osteoporosis were unexpectedly high in women, who are considered to be at risk of high BMI. Heel ultrasound was able to predict low bone mass with sufficiently high sensitivity and specificity for use as a screening tool.

Key words: BMI, BMD, Osteoporosis

INTRODUCTION

Obesity and osteoporosis are two important and developing public health problems worldwide [1-3] Low bone mineral density (BMD) is a major risk factor for osteoporosis and its related fractures [3]. Relationship between body mass index (BMI), weight, height, and BMD was reported for many populations [4-6]. Body weight or BMI has been found to be inversely related to the risk of osteoporotic fracture [3-7]. Bone mineral density (BMD) test measures the density of minerals present in the bones using a special scan. This can be used to assess the strength of bones. Bones naturally become thinner as you grow older because existing bone is broken down faster than the new bone made. As a result of this, calcium and other minerals decrease in the bones and they become light in weight, less dense, and more fragile. The bones might break if it goes thinner and weaker. In clinical trials, it is important to find the patients with osteoporosis and the risk groups in which osteoporosis may occur. Possible risk factors of osteoporosis are height, weight, body mass index (BMI), a medical history, a family history at mother's side,

smoking, an alcohol, and an exercise etc; these are widely analysed[8-13]. Identification of individuals at risk of osteoporosis according to the World Health Organisation (WHO) criteria requiresaccurate measurement of bone mineral density (BMD) andcomparison to a young normal reference population.

The objectives of the study were to investigate which factors were more useful as the risk factors of osteoporosis and relationship of those factors with BMD in women.

MATERIALS AND METHODS

1. Subjects

The study was performed in subjects who visited a public health centre in Bardoli to have a BMD examination from January 2016 to February2016 and the data were collected including BMI, body weight, height, and a BMD.Demographic data including hypertensions, diabetes, menopause, history of fracture, family history of fracture and walking exercises were examined by interviews. Men were excluded from the study as this study was to examine the relationship of BMI and BMD among healthy young women. The subjects who had steroids for a long time, had a thyroid disease or thyroid hormones, and had other osteoporosis treatments or currently took the medications for osteoporosis were excluded as well.

2. *Study variables*

The tool used for data collection consisted of sociodemographic details like age and gender. Height and weight were measured and subjects were dressed in light clothes and did not wear shoes. The BMI was calculated based on the formula weight (kg)/ [height (m)] ^{2}. The standard categorisation of BMI by CDC [14] indicates less than 18.5 as underweight, 18.5–24.9 as Normal, 25.0–29.9 as overweight, and 30.0 and above as obese. T-score, a BMD, was used; when T-score was more than -1 and less than -1, it was defined as a normal BMD and an abnormal BMD, respectively, and these were used as dependent variables in the study. Age, height, body weight, BMI, duration of diabetes, duration of hypertensions, and a walking exercise status were determined as independent variables that could influence on the normal and abnormal BMDs. Awalking exercise was defined in cases of performing a walking exercise at least 30 minutes per day for five days a week.

3. *Analysis methods*

T-test was carried out in order to examine the relationship between normal and abnormal T-scores and age, height, body weight, BMI, a hypertension status, a diabetes status, a walking exercise status. Logistic regression analysis was performed to analyze the relationship between normal and abnormal BMD groups and the independent variables including age, height, body weight, BMI, a hypertension status, a diabetes status, a walking exercise status. Statistical analysis was performed utilizing SPSS 14 software.

RESULTS

The study population consisted of 273 individuals. Age ranged from 25 to 60 years. The respondents were classified in to three broad age groups, 25–39 years, 40–59 years, and 60 years and above. About 65% in the study were in the age group of 25-39 years. 20% of the subjects were obese. A detailed description is given in Table 1.

Table 1: Distribution of respondents according to ageand BMI

Variable	Group	No.	%
Age	25–39	177	65
	40–59	63	23
	60 and above	33	12
BMI	Normal	115	42
	Overweight	103	38
	Obese	55	20

The results of the BMD test of 273 respondents show that 26% were osteopaenic and 25% had osteoporosis. 49% had normal results. Among patients with osteopaenia and osteoporosis, about 72% were overweight. In the present study, 26 participants in the age group 25–39 years had osteoporosis. Maximum number of osteoporosis cases was seen in the age group of 60 years and above. In the age group of 40–59 years, only 38% had osteoporosis. The details of BMD results are given in Table 2.

Table 2: Distribution of bone mineral density according to independent factors

Independent factors		Status of bone mineral density						
		Normal		Osteopaenic		Osteoporotic		
		No.	%	No.	%	No.	%	Total
Age (in Years)	25–39	110	62	41	23	26	15	177
	40–59	21	34	18	28	24	38	63
	60 +	3	4	13	49	17	47	33
BMI	Normal	94	82	14	12	7	6	115
	Overweight	29	28	50	49	24	23	103
	Obese	11	20	8	15	36	65	55
Total		134	49	72	26	67	25	273

For further analysis, the whole group based on the BMD test result was divided as normal and low bone mineral density. There were 134 subjects with normal BMD and 139 with low BMD. BMD was low in 18% of people with normal BMI, 72% among overweight and 80% among obese. The association between BMI and BMD was found to be statistically significant ($p < 0.001$). Agewise variations showed that 38% of those in age group 25–39 years, 66% in 40–59 years of age, and 90% of those aged 60 years and above had low BMD. There was a statistically significant association between BMD and age ($p < 0.01$). The details are depicted in Table 3.

Table 3: Association between bone mineral density and independent factors

Independent factors		Status of bone mineral density					
		Normal BMD		Low BMD		Total	P value
		No.	%	No.	%		Total
Age (in Years)	25–39	110	62	67	38	177	P<0.001
	40–59	21	34	42	66	63	
	60 +	3	4	30	90	33	
BMI	Normal	94	82	21	18	115	P< 0.01
	Overweight	29	28	74	72	103	
	Obese	11	20	44	80	55	
Total		134	49	139	51	273	

DISCUSSION

Osteoporosis is a major public health problem all over the world. The epidemiology of osteoporosis is not well known in most of the Middle East countries. The present study was conducted in South Gujarat, India to identify the factors associated with the incidence of low BMD. The two main factors considered included age and BMI. Although osteoporosis involves the whole body, measurements of BMD at one site can be predictive of fractures at other sites.

The Studies of National Osteoporosis Foundation and others suggested that low BMI should be included in the risk assessment tools for evaluation of osteoporosis and osteoporotic fracture risk [15-17]

Iqbal et al.[18] found that low BMI is a good indicator for referral of women less than 60 years old for measurements of BMD. Similar studies also reported a consistent finding that lower BMI was associated with lower BMD [5-6].

Overweight and obese female were more likely to have osteoporosis and osteopaenia. Similar studies by Felsonet al.[19], Nguyen et al.[20] and Baheiraei et al.[21]also reported the consistent finding that lower BMI was associated with lower BMD.

The previous literature of Baheiraei et al., [21] Jones et al. [22], and Nguyen et al. [23] indicated that advancing age was associated with low BMD. In this study also we observed an association between age and bone mineral density. The chance of low bone mineral density among people with age 60 and above is 23 times higher compared to those with age 25–39 years.In multiple linear regressions analysis on BMD is the dependent variable, where age and BMIwere independent predictors of BMD.

There was no statistically significant difference in the relationship between hypertensions and Diabetes and a BMD in the result of logistic regression analysis as the other variables were controlled. Hypertension is associated with low BMD but there are no studies suggesting that it is the risk factor of osteoporosis.

The study, however, only included age, height, bodyweight (or BMI) as explanatory variables and addressed that BMI is a better predictor for the BMD without considerations of physical exercise and menopause which has an

important effect on women. Further, as BMI better reflect the obesity degree than thesimple body weight, it will be useful, as a risk factor of osteoporosis to explain the relationship between the obesity and the BMD.

Evidence froma review of hereditary versus environmental influences on BMD provides support for a hereditary component in determining peak BMD in young adult women [24]. An evaluation of genetic factors influencing ethnic variations in BMD was outside the scope of this study.Environmental factors such as dietary intake, physical activity, and hormonal factors have also been documented to exert an effect on BMD, although the effect is much less. Environmental influences could be important in the present sample and could be due to culturally determined differences between the groups such as the amount of sunlight exposure. Nutrition is influential to the acquisition of bone mass [25]. Dietary anomalies, particularly in calcium intake, have been implicated in the geographical variations of adult BMD [26-27].

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. These findings highlight the need for osteoporosis prevention efforts in risk group of women. This recommends that regular exercises are required in the prevention of osteoporosis and women, especially, should pay more attentions during the postmenopausal period; osteoporosis examination should be performed on a regular basis and more attentions are required in order to prevent osteoporosis during the postmenopausal period. As the female population of south Gujarat, low BMD in the presence of a small skeletal stature might be associated with increased risk of fractures. If this should be the case, then appropriate interventional measureswill be required to address this particular health issue in South Gujarat [28].

CONCLUSION

The study demonstrated that numerous factors, both modifiable and non-modifiable, were significantly related to the prevalence of osteoporosis. The modifiable factors identified were participation in physical activity (three to five times per week) and body mass index (BMI), whereas nonmodifiable factors included age.The results of this study suggest that advancing age and lower BMI are important risk factors for the occurrence of low BMD. Moreover BMI was more appropriate to explain the association with a BMD when considering variables such as age, Diabetes, Hypertension, exercise.

Further studies are required to investigate the effect of other factors like exposure to sunlight, calcium intake, and other habits like smoking, diet, and so forth.More immediately, the role of weight maintenance in the prevention of osteoporosis is an important public health message that needs to be more widely appreciated.

It is suggested that educational strategies are needed to increase awareness of factors that contribute to maintaining bone health among premenopausal women. Emphasis may be placed on maintaining regular physical activity.

Limitations

Although this study had several findings relevant to the better understanding of the relationship between ages, weight, BMI, and BMD in female population but it has some limitations. In the present study few parameters were not able to take account for analysis i.e. socioeconomic status, educational level, level of physical activity, smoking, alcohol consumption, vitamin D status, sex hormone levels, and nutrition. Selection bias is less likely to affect associations between BMI, and BMD as investigated in this study. Nevertheless, this study provides new data from India, a developing country, which has been underrepresented in past studies.

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