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Relationship between Body Mass Index (BMI) and Bone Mineral Density (BMD) In Women of Manipur

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Abstract:
Background : *Body mass index (BMI) is a good indicator for measurement of bone mineral density (BMD) which measures the density of minerals present in the bones. Dual energy X- ray absorptiometry (DEXA) is the most accurate way to measure BMD.*
Objectives : *This study was performed to evaluate the relationship between BMI and BMD of lumbar spines in women.*
Material and Methods : *This study was conducted on 41 healthy women between the age group of 20 and 45 years. The height (m) and weight (kg) of all the subjects were recorded and BMI was calculated. BMD of lumbar spine was measured using enCORE based X ray bone densitometer (Lunar Prodigy Advance, GE Medical Systems, USA) based on DEXA scan. Statistical analysis was done by using SPSS software version 21. P≤ 0.05 was taken as significant.*
Results : *BMI (22.04± 2.36) kg/m^2 shows a significant positive correlation with BMD (1.202 ± 0.119) , r= 0.327.*
Conclusion : *The results suggest that lower BMI is an important risk factor for the occurrence of low BMD. BMD can be used for screening of osteoporosis.*
Keywords: *BMI, BMD, DEXA scan, Osteoporosis, Women*

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I. Introduction

Osteoporosis is defined as a systemic skeletal disease characterized by low bone mass and micro-architectural deterioration with a consequent increase in bone fragility with susceptibility to fracture[1].

Osteoporosis is a major problem of health care delivery services in both developed and developing countries. The first normative reference database of bone mineral density (BMD) in the Indian women and men was established using digital x-ray radiometry. Further analysis of this database revealed that 29.9 % of women and 24.3 % of men between the age of 20 and 79 years had low bone mass. About 50 % women and 36 % of men over 50 years of age had low bone mass, suggesting a higher prevalence of low bone mass in the Indian population compared to the west[2]. Dual energy X ray absorptiometry (DEXA) is the most accurate way to measure BMD[3].

The combined lifetime risk for hip, forearm and vertebral fractures coming to clinical attention is around 40%, equivalent to the risk for cardiovascular diseases[4].

Osteoporotic fractures are directly related to the bone strength. Bone strength is measured through bone mineral density (BMD), which refers to the amount of mineral per unit of space or mass per volume of the bones. There are many factors influencing BMD and the probability of osteoporotic fractures. Among these, age, gender, race, height, weight, and body mass index (BMI) are considered independent predictors of osteoporotic fractures[5]. However, the effect of BMI on BMD is variable in different ethnic groups. Currently, there is a paucity of data on the relationship between BMI and BMD in the northeast Indian population. So, this study aims to evaluate the relationship between BMI and BMD in an apparently healthy premenopausal northeast Indian population.

II. Material And Methods

This cross sectional study was conducted in the Department of Physiology and Department of Physical Medicine and Rehabilitation, RIMS, Manipur, India from September 2016 to May 2017.

The study was done on 41 healthy women in the age group of 20 to 45 years who have not attained menopause. Pregnant women, women with h/o disease or medication known to affect BMD, females who have undergone hysterectomy with oopherectomy, females on hormonal replacement therapy and subjects who refused to give informed concent were excluded from the study.

Informed written consent was taken from all the subjects after having explaining them the study protocol. Study was approved by the Research Ethics Board, RIMS, Imphal.

The height (m) and weight (kg) of all the subjects were recorded and BMI was calculated. The subjects were classified into following groups according to their BMI: underweight (U) when BMI <18.5 kg/m^2; normal (N) when BMI between 18.5 and 22.9 kg/m^2; overweight (OW) with BMI between 23 and 24.9 kg/m^2; and obese, when BMI ≥ 25 kg/m^2.

BMD of lumbar spine (L1 to L4) was determined using enCORE–based X-ray bone densitometer (Lunar Prodigy advance, GE Medical Systems, USA) based on DEXA scan. Statistical analysis was done using SPSS software version 21. Mean and Standard deviation were assessed. Pearson's Correlation test was done. A $p \leq 0.05$ was taken as significant.

III. Result

Table1. Demographic profile of study population

Sl.no.	Variable	Mean ± SD	No. of participants
1.	Age (years)	24.32±6.86	41
2.	BMI (kg/m²)	22.04±2.36	41
3.	BMD (gm/cm²)	1.202±0.119	41

Table2. Distribution of participants by their BMI

Sl. No.	Category of BMI	N (%)
1.	Underweight (UW)	2 (4.9%)
2.	Normal (N)	28 (68.3%)
3.	Overweight (OW)	6 (14.6%)
4.	Obese (OB)	5 (12.2%)

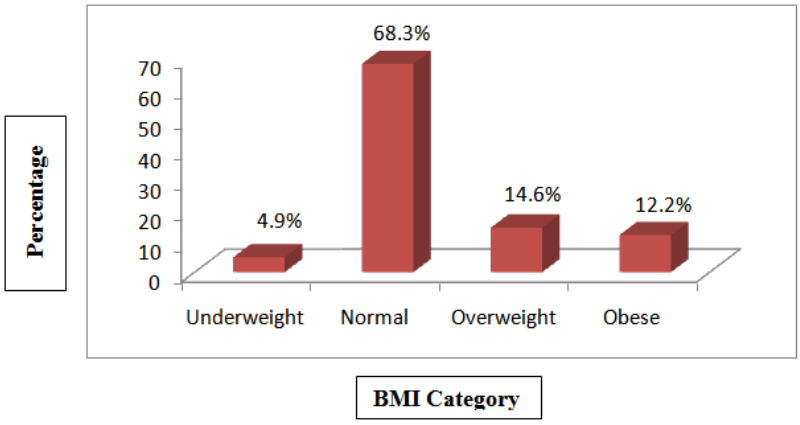

Figure 1: Bar diagram showing the distribution of participants according to their BMI

Table3. Mean age of the different categories of BMI

Sl. No.	Category of BMI	Mean± SD
1.	Underweight (UW)	31±14.14
2.	Normal (N)	22.18±4.19
3.	Overweight (OW)	32±10.31
4.	Obese (OB)	24.40±5.17

Table4. Mean BMD values of the different categories of BMI

Sl. No.	Category of BMI	BMD (gm/cm²)
1.	Underweight (UW)	1.062±0.019
2.	Normal (N)	1.189±0.107
3.	Overweight (OW)	1.287±0.176
4.	Obese (OB)	1.225±0.119

Table5. Pearson's correlation between age, BMI and BMD

		BMI	**BMD**
Age	r	0.146	0.167
	p	0.363	0.296

There is no statistically significant correlation between age and BMI, and also between age and BMD.

Table6. Pearson's correlation between BMI and BMD

		BMD
BMI	r	0.327
	p	0.037*

BMI (22.04± 2.36) kg/m^2 shows a significant positive correlation with BMD (1.202 ± 0.119) , r= 0.327, p< 0.05 i.e. subjects with higher BMI are having high BMD.

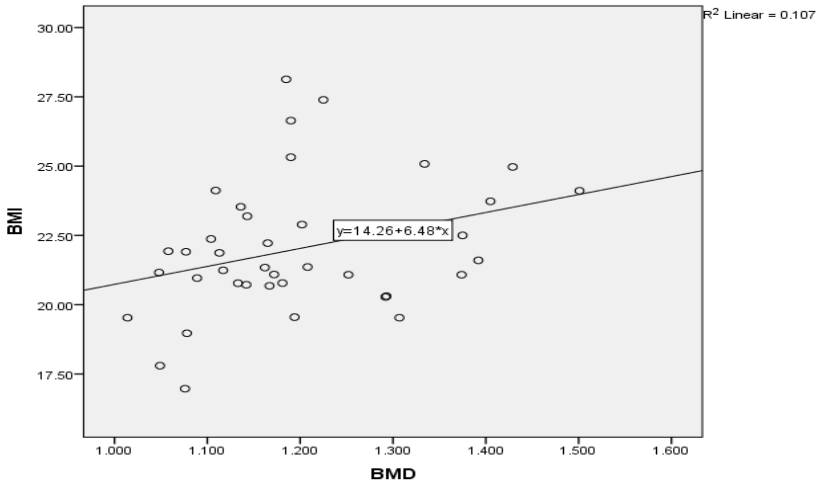

Figure 2: Scatter diagram showing correlation between BMI and BMD

IV. Discussion

It was evident from the results that BMI have a positive correlation with BMD. Baheiraei et al[6] , Nguyen et al[7] and Felson et al[8] in their studies also concluded that there was a significant relationship between BMI and BMD supporting our findings.

The pathophysiological role of adipose tissue in skeletal homeostasis probably lies in the role that several adipokines play in bone remodeling via their effects on either bone formation or resorption. Since the demonstration that bone cells express several specific hormone receptors, the skeleton has come to be considered an endocrine target organ. Additionally, recent observations have shown that bone-derived factors, such as osteocalcin and osteopontin, may affect body weight control and glucose homeostasis, suggesting a possible role of bone tissue as an endocrine organ with the presence of a potential feedback mechanism between the skeleton and endocrine organs. Thus, the cross-talk between fat and bone likely constitutes a homoeostatic feedback system in which adipokines and molecules secreted by osteoblasts and osteoclasts represent the link of an active bone-adipose axis. However, the mechanism(s) by which all these events occur remains unclear.

Fat has long been viewed as a passive energy reservoir, but since the discovery of leptin and identification of other adipose tissue-derived hormones and serum mediators, fat has come to be considered as an active endocrine organ which modulates energy homeostasis. Adipose tissue also secretes various inflammatory cytokines, including interleukin (IL)-6 and tumor necrosis factor-alpha, and altered production of these proinflammatory mediators is thought to have adverse metabolic and cardiovascular consequences. All these molecules, which include resistin, leptin, adiponectin, and IL-6, affect human energy homeostasis and may well be involved in bone metabolism, contributing to the complex relationship between adipose tissue and bone tissue.

Fat tissue is one of the major sources of aromatase, an enzyme also expressed in the gonads, which synthesizes estrogens from androgen precursors. Estrogens are steroid hormones which play a pivotal role in the maintenance of skeletal homeostasis, protecting against osteoporosis by reducing bone resorption and stimulating bone formation. The effect of estrogen on bone and adipose tissue formation has long been recognized in experimental animal models. In humans, changes in estrogen status due to advancing age and menopause have been correlated with increased levels of IL-6 and IL-11, which are both associated with bone

loss. It is interesting to speculate whether the increase in adipogenesis subsequent to menopause is due to a relief of repression or to an induction of the adipogenic phenotype, even though in vitro data suggest that the default "switch" might be adipogenesis, a process which might normally be inhibited in vivo prior to estrogen depletion[9].

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. Other risk factors leading to low BMD 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. Longitudinal studies may be conducted in the future 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 suggest that lower BMI is an important risk factor for the occurrence of low BMD. Hence, BMD can be used for screening of osteoporosis. Apart from screening, it is also essential to create awareness among women about the risk factors of osteoporosis and educate them on possible preventive measures. This will help in reducing morbidity, mortality and socioeconomic burden associated with osteoporosis.

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