RELATIONSHIP BETWEEN BONE MINERAL DENSITY AND BODY MASS INDEX IN ASSOCIATION WITH AGE AND GENDER IN PATIENTS REFERRED FOR DUAL-ENERGY X-RAY ABSORPTIOMETRY

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ABSTRACT

Objective: The objective of our study is to investigate the association between Body mass Index and Bone Mineral Density in association with age and gender.

Methods: A cross sectional observational study was conducted from January 2020 to 2022 at Radiology Department of Hayatabad Medical Complex on individuals referred for DEXA scan. Association was assessed between Bone Mineral Density and Body mass Index in both male, pre and post-menopausal female.

Results: Out of 270 individuals 28.1% were male and 71.9% were female. Mean age was 51+/- 17.05 SD. 39.4% of male had BMI in range of overweight and obese, as opposed to female (86.5%). Increased BMI and decreased BMD was observed in age range of 41-70 years ($p < 0.05$). 26% of post-menopausal female showed osteoporosis as compared to pre-menopausal (20%) ($p < 0.05$).

Conclusion: There is increased risk of osteoporosis with increasing age. Post-menopausal female with increased BMI had decreased BMD.

Keywords: Body Mass Index, Bone Mineral Density, DEXA, Age, Post-menopausal, Osteoporosis

INTRODUCTION

Osteoporosis is characterized by reduction in the bone mass resulting in decreased bone strength and hence a risk factor for fractures of the bone(1). Bone Mineral Density (BMD) is considered a standard for assessment of osteoporosis(2). In developed countries the prevalence of osteoporosis has been reported to be between 13% to 34%(3)(4). Bone Mineral Density is affected by many factors like age, race, sex, weight, height and Body Mass Index (BMI). Others factors increasing the risk of osteoporosis include sedentary life style, hyperthyroidism, smoking, drugs etc (5)(6)(7)(8).

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Several studies have shown a relation between BMI and BMD. Barrera et al conducted a study showing individuals with high BMI value had increased BMD as compared to those who had normal BMI(9). Although there are studies that reveal increased BMD with higher value of BMI, there are other studies that reveal decreased BMD in individuals with obesity(10)(11)(12). Studies reveal increased risk of fragility fractures in women having age greater than 50years of age(13). One possible reason for it may be a 20% increase in fat mass in central adipose tissue in post-menopausal women as compared to pre-menopausal women(14). Weight gain due to increase muscle mass is beneficial rather than weight gain due to increase body fat. Increase in BMI due to increase in body fat increase the risk of osteoporosis(15). A study on a population of Korean women revealed a decrease in bone density in the region of neck of femur(16). The optimum BMI with decreased risk of osteoporosis for post-menopausal women and men >50 years has been reported to be 23-24.9 kg/m^2(17).Post-menopausal osteoporosis occurs due to decrease in level of estradiol which is replaced by estrone. Since estradiol increases activity of osteoblast and inhibits osteoclast, its decreased level causes more bone reabsorption(18).

Strategies to prevent osteoporosis are recommended due to its growing incidence. For this reason the risk factors for osteoporosis needs to be defined. A balance between Body Mass Index and Bone Mineral Density is important. Studies are not clear how much BMI is essential to attain optimum BMD. Therefore we aim to investigate the association between BMI and BMD in a cross sectional population sample of Peshawar in association and gender.

MATERIAL AND METHODS

A cross sectional observational study was conducted at the Radiology Department of Hayatabad Medical Complex. Data was collected retrospectively from January 2020 to 2022. Ethical committee approval was taken before starting the study. We included those patients that were advised Dual Energy X-Ray Absortiometry (DEXA) scan. Patients with history of malignancy, use of steroids, rheumatoid arthritis, disorders of thyroid, parathyroid, adrenals, liver, kidneys; or those undergoing treatment for osteoporosis were excluded from the study.

DEXA scan was performed on the individuals by the Hologic Discovery A machine. The machine was recalibrated daily by scanning a standardized phantom in order to exclude any changes in scan acquisition. Measurements of DEXA were acquired at the L2 to L4 spine and bilateral neck of femori. According to the guidelines outlined by the World Health organization, the BMI acquired was grouped in to underweight (<18.5), normal (18.5-24.9), over weight (25.0- 29.9), obesity I (30.0-34.9), obesity II (35.0-39.9) and obesity III (above 40)(19). BMD was calculated in g/cm^2 T-score or Z-score were calculated. T-score is used for men with age more than 50 years and women who are post-menopausal. It is classified according to WHO as: normal (≥-1.0), osteopenia (<-1.0 to >-2.5), osteoporosis (≤-2.5), severe osteoporosis (≤-2.5 plus fragility fracture). Z- score is calculated for women who are in pre-menopausal age, men with age less than 50 years and children. Value of <-2.0 means the BMD is below expected range(20). Both male and female were grouped in age ranges. Sample of females were sub grouped into pre- and post-menopausal. Statistical analysis was performed using IBM SPSS statistic 20. The level of significance was considered as p< 0.05.

RESULTS

270 individuals were included in our study. Out of 270 individuals, 76 were male (28.1%) and 194(71.9%) were female. The mean age was 51 years +/- 17.05 SD. Highest number of individuals were in age range of 50-70 years. Out of the 194 females 48 (17.8%) were pre-menopausal and 146 (54%) were post-menopausal. 33.3% had normal BMI, 25.2% were in the range of overweight, 17.8% had type I obesity, 12.6% had type II obesity and 6.7% with type III obesity. Most of them with BMI above normal were in age range of 41-70years (figure 1). Low BMD was observed in age range of 51-70 years (Table 1). Out of the 12 underweight individuals, 4 revealed osteoporosis while 4 had severe osteoporosis. 6 were below 20 years while 2 were in age range of 61-70 years. On applying chi square test for cross tabulation between BMI and BMD in different ages, a P <0.05 was observed in age range 61 to 90 years.

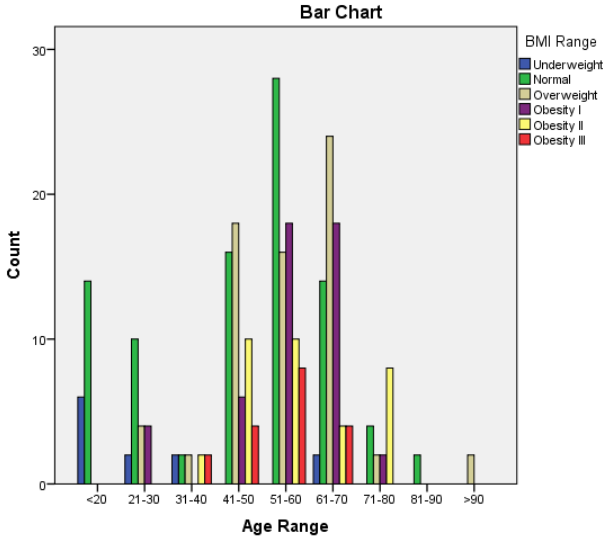

Figure 1: Distribution of BMI with age

Table 1: Distribution of BMD in different age ranges

		BMD Range				Total
		Normal (T-score >-1.0)	Osteopenia (T-Score -1.0 to -2.5)	Osteoporosis (T-Score <-2.5)	Severe Osteoporosis (T-Score <-2.5 with fragility fracture)	
Age Range (years)	<20	10	6	2	2	20
	21-30	8	10	2	0	20
	31-40	4	4	2	0	10
	41-50	12	36	6	0	54
	51-60	26	38	12	4	80
	61-70	12	34	14	6	66
	71-80	4	8	4	0	16
	81-90	0	2	0	0	2
	>90	0	0	2	0	2
Total		76	138	44	12	270

Majority of the males had normal BMI (55.2%) while 77.1% of females had BMI above normal. Majority of males and females had BMD in osteopenic range. Majority of the females who were overweight and obese had BMD in the osteoporotic range. Both males and female who were underweight had increased frequency of osteoporosis (Table 2). A significant percentage of post-menopausal female were overweight and obese with BMD in osteoporotic range ($p < 0.05$) (figure 2). Table 3 shows cross tabulation of BMI and BMD with p value <0.05.

Table 2: BMI Range * BMD Range * Gender Cross tabulation

Gender								BMD Range
								Normal (T-score >-1.0)
Male			BMI Range				Total	P value
			Normal (T-score >-1.0)	Osteopenia (T-Score -1.0 to -2.5)	Osteoporosis (T-Score <-2.5)	Severe Osteoporosis (T-Score <-2.5 with fragility fracture)		
Male	BMI Range Total	Underweight	0	2	2	0	4	0.07
		Normal	12	18	10	2	42	
		Overweight	4	10	0	0	14	
Female	BMI Range	Obesity I	4	2	0	0	6	
		Obesity II	0	6	0	0	6	
		Obesity III	0	2	2	0	4	
	Total		20	40	14	2	76	

Female	BMI Range Total	Underweight	0	2	2	4	8	
		Normal	14	28	6	0	48	
		Overweight	12	24	14	4	54	
		Obesity I	4	24	12	2	42	0.000
		Obesity II	12	12	4	0	28	

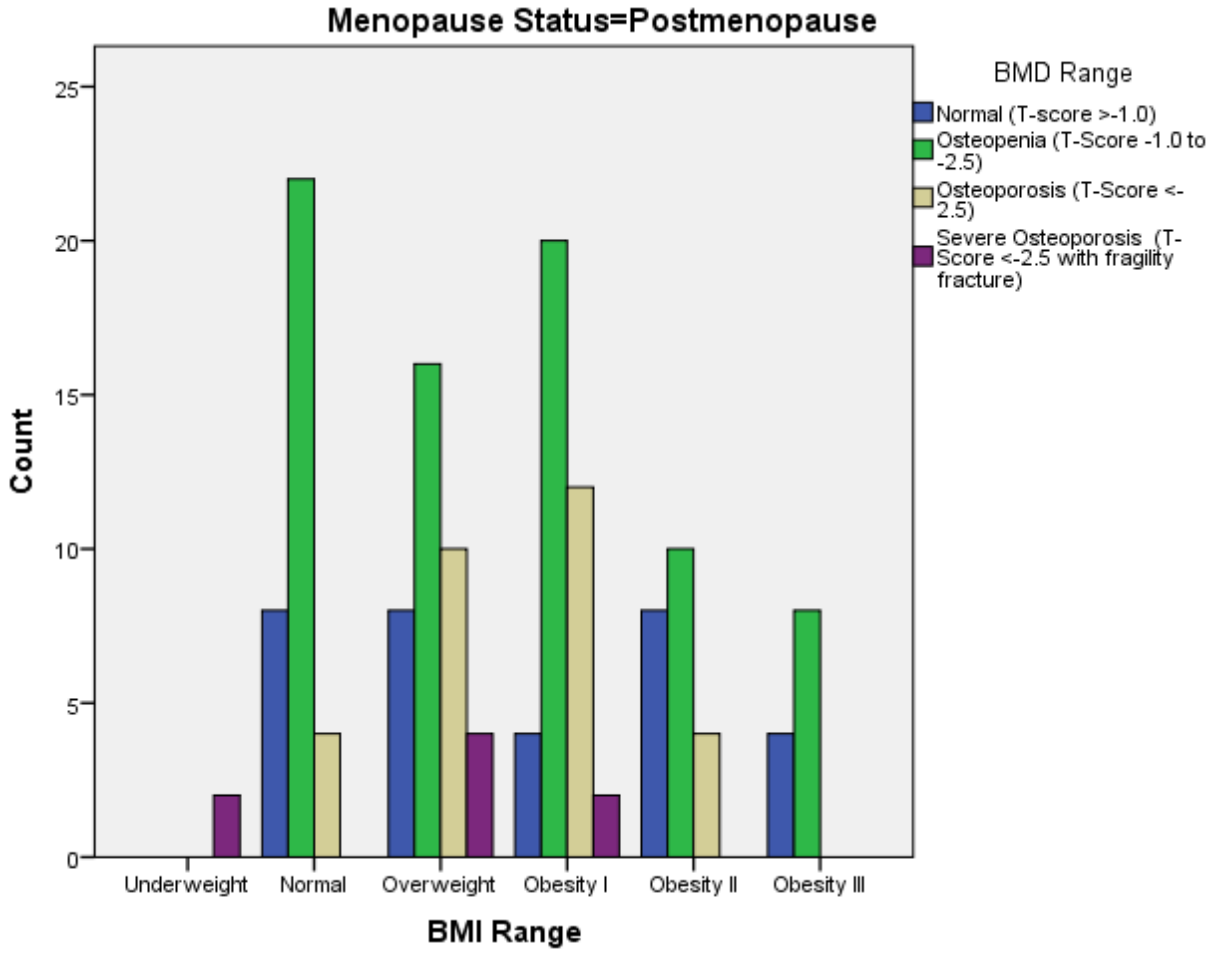

Figure 2: Distribution of BMD and BMD in relation to post-menopausal status

Table 3: BMI Range * BMD Range Crosstabulation

		BMD Range				Total	P value
		Normal (T-score >-1.0)	Osteopenia (T-Score -1.0 to -2.5)	Osteoporosis (T-Score <-2.5)	Severe Osteoporosis (T-Score <-2.5 with fragility fracture)		
BMI Range	Underweight	0	4	4	4	12	0.01
	Normal	26	46	16	2	90	
	Overweight	16	34	14	4	68	
	Obesity I	8	26	12	2	48	
	Obesity II	12	18	4	0	34	
	Obesity III	6	10	2	0	18	
Total		68	138	52	12	270	

DISCUSSION

Our study results showed that individuals with underweight and obese BMI had higher frequency of low BMD. Increasing age and post-menopausal status in female also increased the risk of low BMD. 66.6% of individuals who were underweight revealed osteoporosis. However we also observed a significant percentage of individuals with BMI above normal presenting with osteopenia and osteoporosis. In a study by Ma et al(2) and Hariri et al(21) a positive association was revealed between Body Mass Index and Bone Mineral Density. With increase in BMI the BMD increased when BMI was less than 26kg/m^2(2). Kheirella et al in their study showed that increasing BMI decreased incidence of osteporosis(22). The possible reason for this may be that increased weight caused remodeling of the bones in order to compensate for the increased weight(23). There are some studies which shows the negative relation between BMI and BMD due to effect of fat mass on BMD. The proposed explanation described for it are the increased levels of pro inflammatory cytokines which cause stimulation of bone reabsorption, higher levels of parathyroid hormone and lower levels of adiponectins(24)(25)(26)(27). Wang et al in their study revealed that adolescent male that were overweight/obese had increased risk of decreased BMD(28).

In our study 55% of males had normal BMI followed by 18.4% of males who were overweight. 59.7% of female individuals on the other hand had BMI in range of overweight and obese ($p<0.05$). These findings were similar to study by U Akhlaque et al(29), Nazli et al(30) and Khan et al(31). In our study no statistically significant difference was observed in BMI and BMD in males while in female it was significant with $p<0.05$. Salamat et al(32) and Saadati et al(33) in their study showed no disparity in BMD and BMI on the basis of gender. Kheiralla et al(22) in theirs study revealed that females with increasing age especially post-menopausal showed decreased bone density. This is similar to our study findings which reveals increased BMI and reduced BMD in post-menopausal women. Kim et al(34) in their study on post-menopausal women showed that obese and underweight women had increased risk of osteoporotic bone fractures. Another study showed that longer the period of menopause the greater the tendency for lower BMD(35).

Our study also showed that increasing age is another risk for decreased BMD ($P<0.05$). this is similar to findings by Kheiralla at al (22), U Akhlaque at al (29) and Saadati et al (33). Growth of bone decreases after 45years and there is increased bone reabsorption(22).

Our study is an attempt to assess the various risk factors contributing to osteoporosis which is a very important public health problem. We not only assessed the relation of BMI and BMD but also assessed the effect of age, gender and menopause on BMD and BMI. The findings of our study can be applied to Pakistani population and can help in ways to reduce obesity and osteoporosis. The main limitation in our study is the limited population sample and that it was retrospective study. We observed in our study that a significant

proportion of our population sample was osteopenic irrespective of age and gender. This needs to be further investigated. Also further studies need to be carried out on a larger population and to evaluate the effect of other factors on BMD.

CONCLUSIONS

There is association between BMI and BMD.There is higher frequency of increased BMI in females as compared to men. There is increased frequency of decreased BMD in post-menopausal women and at age greater than 50 years. Both male and female had decreased BMD if they were underweight.

DECLARATIONS

Authors contributions:

MRK designed and collected the data with drafting of the manuscript, MS designed and reviewed the manuscript, MRK analyzed the data with drafting of the manuscript, RI collected the data, GW collected the data, KR analyzed the data.

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