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Relationship between body mass index and bone mineral density in Saudi women above 40 years with vitamin D deficiency

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Abstract: Low body mass index (BMI) causing low bone mineral density (BMD) has been reported in several articles. There are also contradictory data available which shows that obesity is associated with low bone mass. Vitamin D deficiency is a very common problem in Saudi women due to their lifestyle and culture. The present study was conducted to find out the relationship between body mass index and bone mineral density in Saudi women who have vitamin D deficiency. After the Vitamin D level assessment, the patients underwent Dual Energy X-ray Absorptiometry (DEXA) scan. Patients who had hormonal disorders, renal diseases and who were on immunosuppressive drugs were excluded from the study. Among the patients who had Vitamin D deficiency, 42.7 % had normal BMD while 57.3 % had low BMD. The BMD was low in 80% with normal BMI, 74.1% in overweight and 50% in obese patients. There was no statistically significant association between BMI and BMD ($P>0.05$) although there was a significant association between exercise and BMD ($P<0.05$) and age and BMD ($P<0.05$). The results indicate that bone loss and osteoporosis can occur in obese patients above 40 years of age, if they are not having sufficient exercise.

Keywords: Vitamin D Deficiency, Body Mass Index, Bone Mineral Density, Saudi Women

1. Introduction

Obesity and osteoporosis are two complex diseases with multifactorial etiology. Body mass index is a widely used index to measure obesity. Dual Energy X-ray Absorptiometry (DEXA) scan is the preferred method used to measure the bone density. Measurement of bone mineral density is a major component in the diagnosis of osteoporosis. Studies done by S. Morin et al. indicate that low weight and body mass index (BMI) predict osteoporosis as determined by BMD with good sensitivity but low specificity in women aged 40-59 years [1]. The study conducted by Guney E et al. on the effect of weight loss on bone metabolism indicated that weight loss causes bone loss and the mechanism of bone loss is not clear [2]. It may be explained partly by reduced estradiol levels in female patients. Kofi Asomaning et al in their cross sectional study among women aged 50-84 years concluded that women with low BMI are at increased risk of osteoporosis [3]. According to E.A. Greco et al. few and contradictory data are available on skeletal modifications in obese patients [4]. Their studies showed that a subpopulation of obese patients had a significant low BMD than expected which suggested risk of bone loss and osteoporosis. They have suggested that further studies evaluating BMD modification might be useful in both male and female severely obese patients, as ageing may increase their risks of developing fractures later in life.

The studies conducted by Chubak et al. in postmenopausal

obese women showed that exercise does not influence the bone mineral density [5]. On the other hand, the results of the study conducted by Stewart KJ et al. showed that exercise may preserve or increase BMD while reducing fatness [6]. The effect of Vitamin D on bone health is well established. The study conducted by Vieth R illustrates the role of Vitamin D in the prevention of osteoporosis [7]. Since osteoporosis is a multifactorial disease, if the mechanism of bone loss is not clear, it is difficult to determine the most effective treatment. It is important to determine osteopenia early to prevent fractures.

As most of the Saudi women are inside their house during the daytime and due to their way of dressing, exposure to sunlight is minimal. Because of this, Vitamin D deficiency is very common in Saudi women. The present study was therefore undertaken to find out if there was any association between BMI and BMD in Saudi women above 40 years of age who has vitamin D deficiency, as they is no available literature regarding this. Other factors which can alter the bone density like exercise, smoking and dietary habits were also taken into consideration in this study.

2. Materials and Methods

The study was conducted in Arar central Hospital, Arar, Saudi Arabia. 100 female patients who came to the outpatient departments of medicine and orthopedics were selected by simple random sampling over a period of four months. All patients were Saudi women residing in Arar and have completed 40 years of age. Patients who had hormonal disorders, renal diseases and who were on immunosuppressive drugs were not selected for the study. An informed consent was taken from all the patients and a questionnaire relating to age, marital status, smoking habits, diet, exercise, diseases and drugs taken was given to them. Blood sample was collected to assess the Vitamin D level and the patients were sent to the Radiology department of Arar Central Hospital to undergo DEXA scans. Height and weight measurements were taken before the scan in light clothing and without shoes. The vitamin D level <50 nmols/l was considered as Vitamin D deficiency as per the WHO definition [8]. The BMI was calculated from height in cm. and weight in kg. The BMI was categorized as follows: <18.5 was considered underweight, 18.5- 24.9 was considered normal and >30 as obese [9]. BMD was measured at the femoral neck on the right side and left side and the lumbar spines L1 - L4. The DEXA scan report was given by the radiologist. The report was based on the WHO classification ranges of BMD T-score to classify the patients as normal, osteopenic and osteoporotic [10]. The statistical analysis was done to show the distribution of patients in relation, to age, BMI and exercise. To find out whether there is any significant association between BMD and independent factors like age, BMI and exercise, Fisher's exact test was used. The level of significance was fixed at P value <0.05.

3. Results

Among the 100 female patients selected for the study, 82 patients had vitamin D deficiency. Only the data of the patients with Vitamin D deficiency was considered for analysis. Their age ranged from 40-75 years. The mean and standard deviation of the age was 50.78 ±8.49 years. The patients were classified into three age groups, 40- 50years, 51-60 years and >60 years. 65.9% of the patients were in the age group of 40-50 years, 26.8% in the age group 51-60 years and 7.3% in the age group > 60 years. The BMI was normal in only 6.1% of the patients while 93.9% of the patients were overweight or obese. Only 8.5% of the patients were in the habit of doing exercise while 91.5% of the patients were not doing any exercise (Table1)

Table 1. *Distribution of subjects in relation to Age, BMI and Exercise.*

Factor	Factor levels	Count	%
Age group in years	40-50	54	65.9%
	51-60	22	26.8%
	>60	6	7.3%
	Total	82	100.0%
BMI	Normal	5	6.1%
	Overweight	19	23.2%
	Obese	58	70.7%
	Total	82	100.0%
Exercise	NO	75	91.5%
	YES	7	8.5%
	Total	82	100.0%

Table 2. *Bone mineral density distribution in relation to Age, BMI & Exercise.*

Factor	Factor levels	BMD Normal	Osteopenia	Osteoporosis
Age group in years	40-50	27	24	3
		50.0%	44.4%	5.6%
	51-60	8	8	6
		36.4%	36.4%	27.2%
	>60	0	2	4
		0%	33.3%	66.7%
	Total	35	34	13
		42.7%	41.5%	15.8%
BMI	Normal	1	3	1
		20.0%	60.0%	20.0%
	Overweight	5	9	5
		26.3%	47.4%	26.3%
	Obese	29	22	7
		50.0%	37.9%	12.1%
	Total	35	34	13
		42.7%	41.5%	15.8%
Exercise	NO	29	33	13
		38.7%	44%	17.3%
	YES	6	1	0
		85.7%	14.3%	0%
	Total	35	34	13
		42.7%	41.5%	15.8%

The DEXA scan results showed that in the age group 40-50 years, 50% of the patients had normal bone density, 44.4% had osteopenia and 5.6% had osteoporosis. 66.7%of the patients >60 years of age had osteoporosis. 80% of the patients with normal body weight had low BMD while 50% of the obese patients had normal BMD. Among the patients who did exercise 85.7% had normal bone density, 14.3 % had osteopenia and 0% had osteoporosis (Table 2).

To find out whether there is significant association between independent factors like age, BMI, exercise and BMD, Fisher's exact test was performed. The results were considered significant if p-values were <0.05 (Table 3). SPSS 16.0 version was used to facilitate computing and generating results.

Table 3. *Association between Age, BMI, Exercise and BMD.*

Factor	Factor levels	BMD		P-value
		Normal BMD	Low BMD	
Age group in years	40-50	27 50.0%	27 50.0%	0.039
	51-60	8 36.4%	14 63.6%	
	>60	0 0%	6 100.0%	
	Total	35 42.7%	47 57.3%	
BMI	Normal	1 20.0%	4 80.0%	0.133
	Overweight	5 26.3%	14 73.7%	
	Obese	29 50%	29 50%	
	Total	35 42.7%	47 57.3%	
Exercise	NO	29 38.7%	46 61.3%	0.038
	YES	6 85.7%	1 14.3%	
	TOTAL	35 42.7%	47 57.3%	

4. Discussion

Osteoporosis is widely recognized as an important public health problem because of the significant morbidity, mortality and costs associated with its complication- namely fractures of hip, spine, forearm and other skeletal sites [11].The International Osteoporosis Foundation estimates that osteoporosis affects about 200 million women worldwide. Women have lower bone density than men and they lose bone mass more quickly as they advance in age, which leads to osteoporosis in some women. Estrogen is a hormone that helps in regulating the woman's reproductive cycle. At the same time, it also plays a vital role in keeping the bones strong and healthy. According to Hussein et al vitamin D deficiency is common in Saudi Arabia, and contributes adversely to bone health [12]. Vitamin D deficiency should be suspected and treated in all subjects with osteopenia and osteoporosis. It is difficult to assess adequate Vitamin D nutrition as circulating Vitamin D is derived from the diet as well as sunlight. Extensive epidemiological data show that high body weight or BMI is correlated with high bone mass and that reductions in body weight may cause bone loss [13]. Kanis et al have developed a fracture risk assessment tool (FRAX) based on clinical risk factors with or without bone mineral density tests [14]. BMI was included as a continuous variable among the clinical risk factors used to develop the fracture risk assessment. The present study analyzed the factors responsible for the occurrence of low mineral density in Saudi women above 40 years residing in Arar.

Bone mass is a major determinant of fracture risk and can be assessed by noninvasive techniques like dual energy x ray absorptiometry (DEXA). Densitometric criteria based on standard deviation scores expressed in relation to reference values in pre and postmenopausal women (T SCORE) help in evaluating the bone mineral density(BMD).

Among the 100 female patients screened for Vitamin D deficiency, 82% of the patients had Vitamin D deficiency (<50 nmols/l). The finding suggests that Vitamin D deficiency is a serious problem in Arar female population. According to Jacobo Wortsman et al obesity is associated with Vitamin D insufficiency which is likely due to the decreased bioavailability of Vitamin D3 from cutaneous and dietary sources because of its deposition in the body fat compartments [15].

Among the 82 patients who had vitamin D deficiency and were taken for data analysis, 70.7% were obese (BMI>30). Jay j Cao in his review article has stated that obesity is traditionally viewed to be beneficial to bone health because of the established positive effect of mechanical loading conferred by body weight on bone formation [16]. Nevertheless he also states that the mechanisms for the effects of obesity on bone metabolism are not well defined. His conclusion was that accumulating data suggests that obesity is detrimental to bone health despite potential positive effects of mechanical loading conferred by increased body weight with obesity on bones. In our study, we found that 50% of the obese patients (BMI>30) had low BMD while 80% of the patients who had normal weight had low BMD. There was no significant association between BMI and BMD (P value >0.05).

57.3% of the Vitamin D deficient female patients had low BMD. In the age group 40-50 years, 50% had low BMD, while in the age group 51-60 years, 63.3% had low BMD and > 60 years, 100% had low BMD. There was a significant association between age and BMD in the present study (P value <0.05). Only 7 patients (8.5%) were doing some form of exercise of which 6 had normal BMD while 1 had osteopenia. The association between exercise and BMD was significant (P value < 0.05).

According to Law MR et al hip fracture in old age is a major adverse effect of smoking after menopause [17]. In the present study only 5 patients (6%) were in the habit of smoking and all of them had low BMD. The studies of Warensjo et al showed an association between low habitual dietary calcium intake and an increased risk of fractures and osteoporosis [18]. In this study, only 5 patients (6%) were taking diet rich in calcium and vitamin D. This study has

highlighted the major problems among Saudi women above 40 years like Vitamin D deficiency, Obesity and osteoporosis.

5. Conclusion

The results of the present study show that obesity is not a protective factor for BMD in Saudi women above 40 years of age. Exercise, smoking and calcium deficient diet are important factors related to the development of osteoporosis in Saudi women.

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