RESEARCH ARTICLE

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A Cross-Sectional Study to Find the Correlation Between Age and BMI with Bone Mineral Density in Pre and Post-Menopausal Women

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Abstract

Osteoporosis is a silent disease and it generally leads to fragility fracture. The present study compares the Bone Mineral Density (BMD) by portable ultrasonic bone densitometer in premenopausal and post-menopausal women and also examines the association of BMD with age and Body Mass Index (BMI). A cross-sectional study was done among 79 apparently healthy females grouped as pre and post-menopausal females. An elaborate questionnaire was used and BMD was calculated based on the Tscore by a portable ultrasonic bone densitometer. Similar osteopenic changes were observed in both pre and post-menopausal females while osteoporosis was more prevalent in post-menopausal females. There was an inverse correlation between BMI and BMD in both pre and post-menopausal females but it was only significant in premenopausal women. Additionally, there was an increased frequency of osteopenic changes in our participants which suggested a higher risk of osteoporosis in women hence there is a need to treat osteopenia early to prevent osteoporosis and risk of fragility fractures.

Keywords: Bone Mineral Density, Osteopenia, Osteoporosis

1. Introduction

Osteoporosis is a major public health concern because of its silent nature. It occurs when bone mass is lost with the deterioration of the microarchitecture of the human skeleton. The bone mass decreases both in men and women starting from the fourth decade, which causes an increase in the risk of fragility fractures In comparison to men, women experience bone loss more rapidly, especially after the first 5 to 10 years of attaining menopause. This occurs due to the deficiency of estrogen in the body. Men have a slow rate of bone loss throughout their lives[1].

The factors affecting the bone structure and its capacity to withstand trauma are bone strength, geometry and microstructural rigidity. The bone strength is an amalgamation of both the BMD and the quality of bones and most of the time about 90% of the bone strength is determined by the BMD[2]. Mineral density is expressed as a correlation of the T score and the Z score. The WHO has categorised bone loss on the basis of BMD and it has defined the condition as osteoporosis when the BMD T score is less than -2.5 standard deviations and osteopenia where the T score is from -1 to -2.5 standard deviation below the average for a young healthy female[3].

As women attain menopause, they experience accelerated and rapid bone loss within 5 to 10 years because of the decrease in estrogen levels. This bone loss occurs approximately at the rate of 3 to 5% per year. It has been seen that approximately 75% of bone loss for a post-menopausal female is related directly to estrogen deficiency and not as the result of advancing age[4]. In the studies that have been undertaken osteoporosis in post-

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menopausal females has been extensively studied, but there is still room for further studies and research in the prevalence of osteopenia in the premenopausal females. For the prevention of osteoporosis, the acquisition and maintenance of optimum bone health at an early stage in life is highly crucial[5].

Accumulation of bone mass and bone quality depends on many factors. These include genetic predisposition, peak bone mass, balanced nutrition, physical activities, active lifestyle and certain dietary risk factors, like consumption of coffee, tea, carbonated drinks, smoking and alcohol. These are some of the factors that affect the accumulation and maintenance of healthy bone mass[6]. Many stories have inferred that a high BMD is concurrent with a high BMI in women and obesity[7], which may be a factor in decreasing the risk of osteoporosis, but not the risk of osteopenia[8].

The prevalence of osteoporosis and osteopenia in women is so far sparsely under-recognised. Osteoporosis predisposes a person to fragility fractures and these fractures have a high impact on the morbidity and mortality of the elderly population and also put a heavy financial burden on hospitalisation and surgeries. Therefore, it is required to undertake measures to decrease the risk of fragility fractures

2. Materials and Methods

In this study, a total of 79 female candidates were recruited, out of which 43 were pre-menopausal and 36 were post-menopausal females. Women with any present or past history of chronic illness, especially hypothyroidism, pregnancy, hormone replacement therapy, drugs interfering with calcium metabolism, taking vitamin D supplements, already diagnosed with osteoporosis and taking its treatment, bone-enhancing and bone-reducing medication within the past 6 months were excluded from the study.

After obtaining informed consent from the participants, each one was evaluated based on a questionnaire and detailed demographic, menstrual and obstetrical history. Standardised physical measurements were obtained. Weight was measured on a digital scale with light clothing and rounded off to the nearest 0.1 kg. BMI was calculated by dividing the weight in kg by the square of the height in meters. The BMD of all the participants was done by using a portable ultrasonic bone densitometer. This calcaneal quantitative ultrasound is a simple, rapid non-invasive and non-exposure to radiation method for the estimation of BMD. The heel of the left foot of each participant was the site of performing the BMD. Each participant's left heel and lower leg was thoroughly cleaned and the left foot was placed in the designated groove of the BMI machine. The technician recorded the measurements from the machine display panel, which had calculated the BMD automatically. These BMD values were displayed by the machine in the form of a T score. Based on the T scores, the participants were revealed as having a normal score which was less than -1 SD, osteopenia with a T score of -1 to -2.5 SD and osteoporosis with a score of less than -2.5 SD[3].

The statistical analysis of data was performed using the SPSS version 23.0. Here, descriptive data was expressed as frequency, percentage, mean and standard deviation. The correlation of BMD with variables was calculated by Spearmen's rho correlation coefficient test. The P-value of <0.05 was considered statistically significant.

3. Results

After the inclusion and exclusion criteria, 79 females were recruited for the study of which 43 were pre-menopausal and 36 were post-menopausal. Table 1 represents the comparison of baseline characteristics of participants with BMD. Mean ages were 34.86 ± 6.83 years in premenopausal females and 54.11 ± 9.38 years in postmenopausal females.

Table 2 represents the T score in pre-menopausal and post-menopausal women where osteopenic changes in both pre-menopausal and post-menopausal females are almost similar while osteoporosis was more prevalent in post-menopausal females.

Table 1. Comparison of demographic characteristics of pre-menopausal and post-menopausal women with BMD

S No.	Parameters	Pre Menopausal	Post Menopausal
1	Age(years)	34.86±6.83	54.11±9.38
2	BMI(kg/m2)	21.13±3.1	26.73±4.66
3	BMD(T score)	-1.21±0.6	- 1.95±0.71

Table 2. T score in pre-menopausal and post-menopausal women

T score	Pre menopausal (N = 43)		Post menopausal (N = 36)	
	Number	%	Number	%
< -1	19	44.18	04	11.11
-1 to -2.5	23	53.4	19	52.7
< -2.5	1	2.3	13	36.11

Table 3. Correlation coefficient between BMD and various variables

VAR00004			Age	BMD	BMI
1.00 (Pre-menopausal) BMD BMI	Age Sig. (2-Tailed) N	Pearson Correlation	1	-.290	.022
			.060	.887	
		43	43	43	
	Pearson Correlation	.290	-1	.433**	
	Sig. (2-Tailed)	.060		.004	
	N	43	43	43	
	Pearson Correlation	.022	-.433**	1	
	Sig. (2-Tailed)	.887	.004		
	N	43	43	43	
2.00 (Post-menopausal) BMD	Age Sig. (2-Tailed) N	Pearson Correlation	1	-.226	.181
			.184	.291	
		36	36	36	
	Pearson Correlation	.226	--1	.318	
	Sig. (2-Tailed)	.184		.059	
	N	36	36	36	
	BMI Sig. (2-Tailed) N	Pearson Correlation	.181	-.318	1
		.291	.059		
		36	36	36	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 3 depicts the correlation between BMD and other variables. In both pre-menopausal and post-menopausal females, a negative correlation between BMD and age (0.290) was observed. A significant correlation was found between BMI and BMD (-0.433) in pre-menopausal females but no significant correlation was observed between BMI and BMD in post-menopausal females. Also, the correlation value among different variables was higher in pre-menopausal females.

4. Discussion

The present study concludes that there is an inverse correlation between age and BMD in both pre-menopausal and post-menopausal females and the frequency of osteoporosis increases as the age progresses. The decrease in the levels of the female hormone estrogen after menopause has an osteopenic effect on bones. Studies have shown that estrogen is responsible for the apoptosis of osteoclasts, and thus it maintains a desired ratio between the osteoblastic cells and the osteoclasts[9,10].

In this study, the incidence of osteopenia was almost similar in both pre-menopausal and post-menopausal women (53.4% and 52.7% respectively) but there was a greater incidence of osteoporosis in post-menopausal women. All the factors that were responsible for decreased bone mass consistently persisted in pre-menopausal as well as post-menopausal women. These osteopenic factors along with estrogen deficiency make women prone to osteoporosis after the attainment of menopause. We have seen osteopenic changes in adult females that can be explained by a decrease in ideal peak bone mass. Many previous studies suggested that the adult peak bone density is the greatest contributor to BMD than the subsequent gradual rate of bone loss until the final 15 years[11]. After menopause, a reduction of almost 50% of fracture risk in elderly patients was seen if the peak bone mass had an increase of 10%[12]. Therefore attainment of high peak bone mass in the first three decades of life would significantly contribute to the prevention of osteoporosis in an elderly age[13].

BMI and BMD are significantly correlated in pre-menopausal females (-0.433) and this association is inverse in our study. The mean BMI in premenopausal females was 21.13±3.1 kg/m^2 which comes under the normal BMI range, although we find no significant correlation of BMI with BMD in post-menopausal females. According to the WHO classification, underweight is defined as having a BMI < 18.5 kg/m^2, normal weight as a BMI of 18.5–24.9 kg/m^2, overweight having a BMI of 25.0-29.9 kg/m^2, obesity class I BMI 30.0-34.99 kg/m^2, obesity class II BMI 35.0-39.99 kg/m^2 and obesity class III BMI >40.0 kg/m^2 [14].

Many previous studies have attempted to find the relation between BMD and BMI and have shown conflicting results. Some studies have indicated that having a high BMI is protective against osteoporosis[15], but few studies have shown opposite findings[16].

The association between adipose tissue and bone tissue is affected by a lot of factors like mechanical and metabolic factors[17]. Increased physical loading due to increased adipose tissue is a protection from osteopenia[18]. Peripheral aromatase is a hormone present in the adipose tissue that is responsible for the peripheral synthesis of estrogen, which in turn promotes bone formation and reduces bone resorption[19]. Several other factors are also involved. Leptin, which is secreted from adipocytes is known to have both positive[20] and negative effect[21] on the formation of bone and hence its role is controversial. An increase in adipose tissue is also linked with an increase in inflammatory markers like CRP, TNF α and sIL 6, leading to inhibition of adiponectin and thus an increase in bone density[22]. Given all these factors just having a high BMI or weight gain is not the healthy approach to preserving bone health instead other healthier means like regular exercise, a healthy diet and attaining a healthy lifestyle should be promoted.

5. Conclusion

The study shows a high prevalence of osteopenia in both pre-menopausal females and post-menopausal females. Early detection of osteopenia is essential in pre-menopausal females to reduce the prevalence of osteoporosis later in the post-menopausal stage. Having a high BMI exerts a positive effect on BMD, the mechanism of which is still not entirely clear. The studies that were designed to examine the effect of increased BMI on bone health in humans have been observational and hence they can only hint at a suggestion, but cannot prove the correlation between a high BMI and high BMD.

6. References

1. Manolagas SC. Birth and death of bone cells: Basic regulatory mechanisms and implications for the pathogenesis and treatment of osteoporosis. Endocr Rev. 2000; 21(2):115-37. https://doi.org/10.1210/edrv.21.2.0395 PMid:10782361.
2. Holroyd C, Cooper C, Dennison E. Epidemiology of osteoporosis. Best Pract Res Clin Endocrinol Metab. 2008; 22:671-85. https://doi.org/10.1016/j.beem.2008.06.001 PMid:19028351.
3. Lane NE. Epidemiology, etiology, and diagnosis of osteoporosis. Am J Obstet Gynecol. 2006; 194:S3-11. https://doi.org/10.1016/j.ajog.2005.08.047 PMid:16448873.
4. Kleerekoper M, Al-Khayer F. Osteoporosis, overview. Encyclopedia of Endocrine Diseases. 2004; 3:425-31. https://doi.org/10.1016/B0-12-475570-4/00952-5
5. Cecily HSJ. Early detection and prevention of osteoporosis among pre and Post-menopausal women in Saudi Arabia. Clin Nurs Res. 2020; 29(1):48-55. https://doi.org/10.1177/1054773818769209 PMid:29631417.
6. Korkmaz N, Tutoğlu A, Korkmaz I, *et al.* The relationships among vitamin D level, balance, muscle strength and quality of life in postmenopausal patients with osteoporosis. J Phys Ther Sci. 2014; 26:1521-6. https://doi.org/10.1589/jpts.26.1521 PMid:25364102. PMCid: PMC4210387.

7. Handa R, Ali Kalla A, Maalouf G. Osteoporosis in developing countries. Best Pract Res Clin Rheumatol. 2008; 22:693-708. https://doi.org/10.1016/j.berh.2008.04.002 PMid:18783745.
8. WHO: Scientific group on the prevention and management of osteoporosis. Prevention and management of osteoporosis: Report of a WHO Scientific Group. Geneva, PA. Geneva: World Health Organization; 2000. p. 1-3.
9. Fahim F. The magnitude of low bone mineral [corrected] density in middle and old age women. J Pak Med Assoc 2005; 55:500- 2. Erratum in: J Pak Med Assoc. 2006; 56:146.
10. Nelson HD, Helfand M, Woolf SH, Allan JD. Screening for postmenopausal osteoporosis: A review of the evidence for the U.S. Preventive Services Task Force. Ann Intern Med. 2002; 137:529-41. https://doi.org/10.7326/0003-4819-137-6-200209170-00015 PMid:12230356.
11. Hui SL, Slemenda CW, Johnston CC., Jr. The contribution of bone loss to postmenopausal osteoporosis. Osteoporos Int. 1990; 1:30-4. https://doi.org/10.1007/BF01880413 PMid:2133638.
12. Cummings SR, Black DM, Nevitt MC, Browner W, Cauley J, Ensrud K, Genant HK, Palermo L, Scott J, Vogt TM. Bone density at various sites for prediction of hip fractures. The Study of Osteoporotic Fractures Research Group. Lancet. 1993; 341(8837):72-5. https://doi.org/10.1016/0140-6736(93)92555-8 PMid:8093403.
13. Eisman JA, Kelly PJ, Morrison NA, Pocock NA, Yeoman R, Birmingham J, Sambrook PN. Peak bone mass and osteoporosis prevention. Osteoporos Int. 1993; 3(1):56-60. https://doi.org/10.1007/BF01621865 PMid:8499027.
14. World Health Organization. Obesity: Preventing and managing the global epidemic. Geneva, Switzerland: World Health Organization; 2000.
15. Lloyd JT, Alley DE, Hawkes WG, Hochberg MC, Waldstein SR, Orwig DL. Body mass index is positively associated with bone mineral density in US older adults. Arch Osteoporos. 2014; 9:175. https://doi.org/10.1007/s11657-014-0175-2 PMid:24664472.
16. Greco EA, Fornari R, Rossi F, Santiemma V, Prossomariti G, Annoscia C, Aversa A, Brama M, Marini M, Donini LM, Spera G, Lenzi A, Lubrano C, Migliaccio S. Is obesity protective for osteoporosis? Evaluation of bone mineral density in individuals with high body mass index. Int J Clin Pract. 2010; 64(6):817-20. https://doi.org/10.1111/j.1742-1241.2009.02301.x PMid:20518955.
17. Gkastaris, K. *et al.* Obesity, osteoporosis and bone metabolism. J Musculoskelet Neuronal Interact. 2020; 20:72-381.
18. Addison O, Marcus RL, Lastayo PC, Ryapn AS. Intermuscular fat: A review of the consequences and causes. Int J Endocrinol. 2014; 309570. https://doi.org/10.1155/2014/309570 PMid:24527032 PMCid: PMC3910392.
19. Almeida, M. *et al.* Estrogens and androgens in skeletal physiology and pathophysiology. Physiol Rev. 2017; 97(1):135-87. https://doi.org/10.1152/physrev.00033.2015 PMid:27807202 PMCid: PMC5539371.
20. Pasco JA *et al.* Serum leptin levels are associated with bone mass in non-obese women. J Clin Endocrinol Metab. 2001; 86(5):1884-7. https://doi.org/10.1210/jc.86.5.1884
21. Ruhl CE, Everhart JE. Relationship of serum leptin concentration with bone mineral density in the United States population. J Bone Miner Res. 2002; 17(10):1896-1903. https://doi.org/10.1359/jbmr.2002.17.10.1896 PMid: 12369793.
22. Fasshauer M *et al.* Hormonal regulation of adiponectin gene expression in 3T3-L1 adipocytes. Biochem Biophys Res Commun. 2002; 290(3):1084-9. https://doi.org/10.1006/bbrc.2001.6307 PMid:11798186.