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Vitamin D, intact parathyroid hormone, and bone mineral density in postmenopausal women

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Abstract

Background: Osteoporosis and vitamin D deficiency (VDD) are growing concerns for the elderly population, especially postmenopausal women worldwide. The association between osteoporosis and VDD among Bangladeshi postmenopausal women was not adequately evaluated.

Objective: To assess the association between VDD, intact parathyroid hormone (iPTH) status, and bone mineral density (BMD) status among postmenopausal Bangladeshi women

Methods: This single-center, cross-sectional study included 60 postmenopausal women. A pre-designed case record form was used to record baseline demographic variables. BMD was assessed using dual-energy X-ray absorptiometry on eligible patients who met the inclusion and exclusion criteria, where T-scores indicating normal (> -1), osteopenia (-1 to -2.5), or osteoporosis (< -2.5) based on lumbar spine (LS) and femoral neck (FN) measurements. Vitamin D was categorized as deficient (<20 ng/mL), insufficient (VDI: 20–29 ng/mL), or sufficient (≥30 ng/mL) based on serum 25(OH)D levels. Vitamin D and iPTH were measured by chemiluminescence immunoassay.

Results: Among 60 postmenopausal women, 43.3% had osteoporosis and 56.7% had no osteoporosis. VDD, insufficiency, and sufficiency were present in 50%, 35%, and 15% respectively in the study participants. Serum iPTH was higher in 20.0% of the study participants. Vitamin D levels were lower in women with osteoporosis than those without [15.6±5.5 vs. 20.6±8.9, p <0.001]. Serum iPTH negatively and moderately correlated with 25(OH)D and LS-BMD [both: r=-0.4, p=0.001] but not with FN-BMD. In multivariate regression analysis, only serum iPTH [B=0.4, p=0.001] and vitamin D insufficiency [B= 0.5, p=0.015] had a predictive association with LS-BMD.

Conclusion: Both VDD and osteoporosis, are common in postmenopausal Bangladeshi women. Low vitamin D levels can play a role in developing osteoporosis by increasing bone remodeling as an effect of raised iPTH. *[J Assoc Clin Endocrinol Diabetol Bangladesh,* July 2024;3(2)*: 47-52]*

Keywords: Osteoporosis, Vitamin D, Bone mineral density, Parathyroid hormone, Postmenopausal women

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Introduction

Vitamin D is important for the optimum functioning of the musculoskeletal system as it stimulates dietary calcium absorption, the mineralization of the osteoid, and have a regulating role in bone turnover and muscle function.[1] Vitamin D deficiency (VDD) is quite prevalent, especially in postmenopausal women, and worldwide almost one billion people are suffering from vitamin D insufficiency (VDI) or VDD.[2] In adults, VDD is manifested as muscle weakness, bone mineralization

defect (leading to osteomalacia and osteoporosis), muscle pain, reduced bone mineral density (BMD) as well as higher incidence of fractures and falls. Biochemically, low vitD is associated with an increase in serum parathyroid hormone (PTH) concentration which contributes to some of the deleterious effects of VDD.[1]

BMD represents the density or thickness of the bone. It is an indirect indicator of osteoporosis and a predictor of fracture in clinical medicine. Dual energy X-ray absorptiometry (DEXA) is the most widely used methodology for BMD measurements. This test measures the bone density of the pelvis or spine. The bone density can also be measured at the lower arm, wrist, finger, or heel by ultrasound bone densitometer.[3]

There is a rich ongoing debate about the association between 25-hydroxyvitamin D [25(OH)D] and BMD. Some studies suggest that a low serum 25(OH)D is associated with low BMD, while others suggest no significant association between the two variables. These studies are very distinct from each other regarding population characteristics; only a few of the studies are population-based.[4]

There are reports of co-existence of VDD and low BMD among postmenopausal women of many countries of the world. Still, little information is available between the association of vitamin D status and osteoporosis in Bangladeshi postmenopausal women.[5] Hence, the present study aimed to assess the association between VDD and osteoporosis in postmenopausal Bangladeshi women.

Methods

Study population: This cross-sectional study was conducted for six months (January 2021 to June 2021), after taking ethical approval from the Institutional Review Board of Dhaka Medical College, Dhaka. Postmenopausal women (n=60) with at least one year of amenorrhea and age more than 45 years were recruited from the outpatient Department of Dhaka Medical College Hospital, Dhaka, Bangladesh. Written informed consent was obtained from all study participants. General and demographic information of study participants were taken by qualified personnel. Women with endocrine diseases (e.g., Cushing syndrome, hyperthyroidism, primary or secondary hyperparathyroidism), and suffering from other illnesses like advanced renal disease, hepatic dysfunction, and other advanced comorbid conditions were excluded from the study. Women on steroid therapy or any anti-osteoporotic medications like hormone replacement therapy or bisphosphonates were also excluded.

Biochemical measurements: Serum 25(OH)D was measured by automated chemiluminescence immunoassay (Alinity i Abbott, USA). Women were classified based on vitamin D levels as deficient (<20 ng/mL); insufficient (20– 29 ng/mL); and sufficient (≥30 ng/mL) according to the Endocrine Society's recommendations.[6] Serum intact PTH (iPTH) was measured by automated chemiluminescence immunoassay (Alinity i Abbott, USA). Hyperparathyroidism was defined as an iPTH >65 pg/mL.[7]

Bone mineral density: BMD was measured by dual-energy X-ray absorptiometry (DEXA) at the lumbar spine (LS) and either the left or right femoral neck (FN). BMD values were interpreted as T-score and the lowest T-score at any of these sites was taken as the representative T-score. T-score was calculated as the difference between the measured BMD of the patient and the expected bone density value in a normal young person (YN) divided by the population SD [T-score= (BMD−YN)/SD]. Normal T-score was defined as a level more than −1, osteopenia from −1 to −2.5, and osteoporosis less than-2.5.[8]

Statistical analysis: Analysis was performed with SPSS Software (version 20) and, results were presented as absolute values (percentage) and mean ± standard deviation (SD). Student's t-test and Pearson's chi-square test were used to assess the association between the two groups. Pearson's correlation test was used to see the correlation. In multivariate linear regression analysis, the dependent variables were FN-BMD and LS-BMD and the independent variables were age, BMI, years since menopause, iPTH, and vitamin D.

Results

Among 60 postmenopausal women, 43.3% had osteoporosis and 56.7% had no osteoporosis [osteopenia: 32 (53.3%), normal: 2 (3.3%)]. Women with osteoporosis had similar age, years since menopause, BMI, and iPTH levels in comparison to women without osteoporosis. FN-BMD detected more cases of osteopenia (57% vs. 47%) and osteoporosis (32% vs. 17%) than LS-BMD. Although vitamin D levels were lower in women with osteoporosis than those without, there was no significant association with vitamin D status (Table-I).

The VDD and not-VDD [sufficiency: 9 (15%), insufficiency: 21 (35%)] were present equally in the

Table-I: Characteristics of the study participants based on BMD status (n=60)

Variables	Total (n=60)	Non-osteoporosis (n=34, 57%)	Osteoporosis (n=26, 43%)	p-value
Age (years)	61.6±9.7	62.8±9.4	63.4±10.3	0.790
Years since menopause	11.25±4.7	10.7±4.3	11.8±5.1	0.397
≥20 years	11 (18.3)	5 (45.5)	6 (54.5)	0.406*
<20 years	49 (81.7)	29 (59.2)	20 (40.8)	
BMI (Kg/m2)	25.4±2.8	25.3±3.0	25.1±2.7	0.640
LS BMD (gm/cm2)	0.8±0.2	0.8±0.1	0.7±0.2	0.005
LS T Score	-1.4±1.2	-0.93±1.03	-1.98±1.3	0.005
FN BMD (gm/cm2)	0.7±0.2	0.7±1.0	0.6±0.1	0.002
FN T score	-1.9±1.2	-1.68±0.83	-2.4±1.0	0.002
25(OH)D (ng/mL)	20.9±9.04	20.6±8.9	15.6±5.5	<0.001
Sufficiency: ≥30	9 (15.0)	3 (8.8)	6 (23.1)	
Insufficiency: 20 – 29	21 (35.0)	13 (38.2)	8 (30.8)	0.306*
Deficiency: <20	30 (50.0)	18 (53.0)	12 (46.1)	
iPTH (pg/mL)	53.9±21.2	55.4±16.7	57.9±24.7	0.580

BMI (body mass index), BMD (bone mineral density), FN (femoral neck), LS (lumbar spine), iPTH (intact parathyroid hormone)
Student's t-test, Pearson's chi-square test

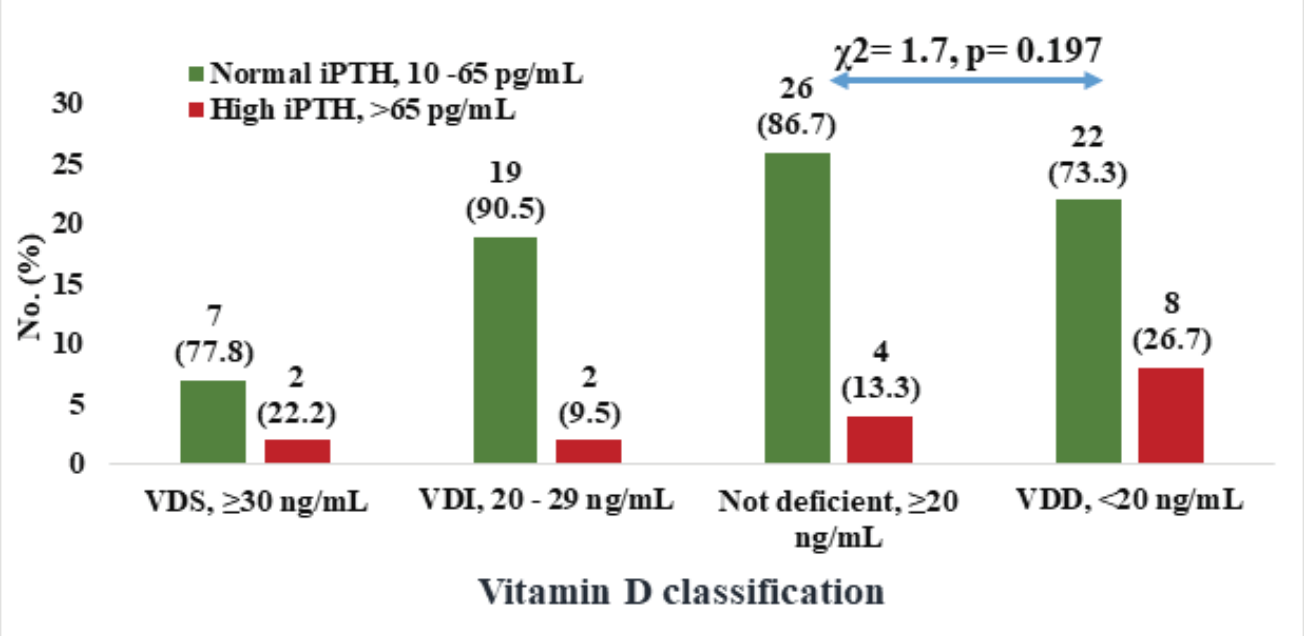

Figure-1: Association between vitamin D statuses with intact parathyroid hormone statuses in the study population (n= 60)

VDS (vitamin D sufficiency), VDI (vitamin D insufficiency), VDD (vitamin D deficiency), iPTH (intact parathyroid hormone)
Pearson's chi-square test was done

Table-II: Correlations among 25(OH)D, iPTH, LS-BMD, and FN-BMD in the study population (n=60)

Variables	25(OH)D r(p)	LS-BMD r(p)	FN-BMD r(p)
25(OH)D		0.1 (0.397)	<0.1 (0.417)
iPTH	-0.4 (0.001)	-0.4 (0.001)	-0.2 (0.128)

LS (Lumber spine), FN (Femoral neck), BMD (bone mineral density)
Pearson correlation test was done

study participants. Serum iPTH was higher in 12 (20.0%) and normal in 48 (80.0%) in the study participants. There was no significant association between vitD and iPTH statuses (Figure-1).

Serum iPTH negatively and moderately correlated with 25OHD and LS-BMD but not with FN-BMD (Table-II).

In multivariate regression analysis, only serum iPTH, and VDI had predictive associations with LS-BMD (Table-III).

Table-III: Predictors of bone mineral density at lumbar (LS-BMD) and femoral neck (FN-BMD) sites in the study participants (n=60)

Independent variables	r2	B	p	r2	B	p
Age (years)	<0.1	-0.1	0.277	<0.1	-0.1	0.574
Body mass index (kg/m2)	<0.1	<-0.1	0.827	<0.1	-0.2	0.270
Intact parathyroid hormone, pg/mL	0.2	0.4	**0.001**	<0.1	0.1	0.821
Vitamin D (ng/mL) Sufficiency, ≥30	0.1	0.3	0.515	0	<-0.1	0.956
Insufficiency, 20 – 29	0.3	0.5	**0.015**	0.1	0.3	0.275
Deficiency, <20	0.1	-0.4	0.055	0.1	0.2	0.207

Multivariate linear regression analysis was done with LS-BMD and FN-BMD as dependent variables

Discussion

VDD has been recently described as a pandemic condition with significant consequences for individual and public health, related not only to musculoskeletal health but also to a wide range of different chronic diseases.[1] Several studies have shown that low serum vitamin D and calcium levels and high PTH levels are the most important risk factors in developing osteoporosis. Our study revealed that the prevalence of VDD was 50%, insufficiency was 35%, and sufficiency was 15%, respectively this finding was consistent with other studies in Bangladesh and other Asian countries. The prevalence of VDD in post-menopausal women was found to be 47% in Thailand, 49% in Malaysia, 90% in Japan, and 92% in South Korea.[5] This study considered the association of serum 25(OH) D levels, iPTH, and BMD in healthy post-menopausal women irrespective of dietary intake and sun exposure.

In this study around 56% to 40% of patients were suffered from osteopenia and osteoporosis in the deficient group, 57% to 38% suffered from osteopenia and osteoporosis in VDI respectively. Remarkably, this study showed patients with vitamin D sufficient group had osteopenia and osteoporosis, that was comparable to a previous study[5].

In this work, no significant correlation was found between vitamin D levels and BMD (both LS and FN). Similarly a study found no association between 25(OH)D and BMD at any of the skeletal sites after adjusting for age, duration of menopause, body mass index, calcium, and PTH.[4] In contrast, a significant correlation was seen between age and BMD, vitamin D and BMD, and age with Vitamin D in another study.[3]

The relationship between 25(OH)D and BMD is still a debatable issue. This can be explained by differences in population, age group, and the vitamin D levels used to classify deficiency and insufficiency in different studies.[5] However the optimal level of vitamin D is still controversial and different authors use different vitamin D level in their study. Parfitt et al. found VDD at 25 nmol/l, while other authors based on PTH established normal vitamin D values at 37 nmol/l to 50 nmol/l.9 VDI leads to secondary hyperparathyroidism and we found a negative correlation between iPTH and vitamin D. Raised PTH concentrations may play a role in the development of increased bone remodeling and bone loss in postmenopausal women with VDD, according to this biochemical picture of our study. We found 25(OH)D responsible for a 42% variation in iPTH value. A study found that 27% of the cases with VDD had secondary hyperparathyroidism and 25(OH)D concentration was significantly lower in these cases.[1]

In contrast, a study showed no correlation between iPTH and vitamin D at any of the vitamin D cut-off values. This conclusion could be attributable to the fact that they included relatively young postmenopausal women under the age of 70. This disparity could be explained by the fact that older women are more likely than younger postmenopausal women to acquire secondary hyperparathyroidism.[8] Similar findings were described by a study where vitamin D and iPTH, or iPTH and osteoporosis, were found to have no statistically significant connection.[5] These results can be explained by the smaller number of sample size. Present study also detected that women with osteoporosis have raised iPTH than non-osteoporotic women. In addition, there was a strong negative relation between iPTH level and LS BMD; this elucidates the significance of the hormone in postmenopausal women's bone loss. Similar finding was observed in the study done by P. Aguado et al.[10]

The present study showed an increased prevalence of osteoporosis in participants whose menopausal years >20. A similar relationship between menopausal duration and BMD was found in the study by B. Heidari et al.[11-13]

Although this study did not show a significant

correlation between 25(OH)D and BMD in the LS and FN, present data did reveal a strong negative correlation between iPTH and 25(OH)D. A similar result was found by a study.[14] This biochemical picture suggests that increased concentrations of PTH might play an important role in the development of increased bone remodeling and bone loss in postmenopausal women with vitamin D insufficiency. In contrast to the present study and previous reports, Villarreal et al. did not find a correlation between 25(OH)D and iPTH at physiological concentrations in their population.[15-17]

The limitations of the present study include those typically associated with cross-sectional studies. All the subjects studied were from a single center, so the sample may not be representative of the general population. Furthermore, factors like sunlight exposure, dietary habits, physical activity, and the presence of diabetes were not considered as variables, which were also limitations of this study.

Conclusion

VDD and osteoporosis are highly prevalent in post-menopausal Bangladeshi women. Although a direct relationship could not be established between 25(OH)D and BMD, but VDD coexists with low BMD. Significant negative correlation was found between vitamin D and iPTH and iPTH was negatively correlated with BMD. Low vitamin D levels can play a role in developing osteoporosis by increasing bone remodeling as an effect of raised iPTH. Increased duration of menopause should be taken into attention to intensify screening of postmenopausal women because of its higher relative risk of developing Osteoporosis.

Conflict of interest

The authors have no conflicts of interest to disclose.

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Disclosure

The authors have no multiplicity of interest to disclose.

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Data Availability

Any inquiries regarding supporting data availability of this study should be directed to the corresponding author and are available from the corresponding author on reasonable request.

Ethical Approval and Consent to Participate

This study was approved by the Institutional Review Board (IRB) of Dhaka Medical College, Reg: No. ERC-DMC/ECC/2020/96. All procedures performed in studies involving human participants were in accordance with the ethical standards of the IRB and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed written consent was taken from the individuals or guardians was obtained from each of the participants included in the study.

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References

1. Capatina C, Carsote M, Caragheorgheopol A, Poiana C, Berteanu M. Vitamin D deficiency in postmenopausal women - Biological correlates. Maedica (Bucur) 2014;9(4):316-22. PMID: 25705298.
2. Tariq S, Tariq S, Khaliq S, Baig M, Murad MA, Lone KP. Association between vitamin D and resistin in postmenopausal females with altered bone health. Front Endocrinol (Lausanne) 2021;11:615440. DOI: 10.3389/fendo.2020.615440.
3. Madhubala V, Anusha R. Vitamin D levels and bone mineral density in postmenopausal women. Int J Clin Biochem Res 2017; 4(4): 335-37.
4. Hosseinpanah F, Rambod M, Hossein-nejad A, Larijani B, Azizi F. Association between vitamin D and bone mineral density in Iranian postmenopausal women. J Bone Miner Metab 2008;26(1):86-92. DOI: 10.1007/s00774-007-0791-7.
5. Ahmed AKMS, Haque WMMU, Uddin KN, Abrar FA, Afroz F, Huque, HF, et al. Vitamin D and bone mineral density status among postmenopausal Bangladeshi women. IMC Journal of Medical Science 2018;12(2):44-49.
6. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, et al. Evaluation, treatment, and prevention of vitamin D deficiency: An Endocrine Society clinical practice guideline. J Clin Endocrinol Metab 2011;96(7):1911-30. DOI: 10.1210/jc.2011-0385.
7. Donal F, Eamon L, Mary W, Leane H, Catherine FH, Strain JJ, et al. Secondary hyperparathyroidism: Predictors and relationship with vitamin D status, bone turnover markers and bone mineral density. Bone 2024;184:117108. DOI: 10.1016/j.bone.2024.117108.
8. World Health Organization. Assessment of fracture risk and its application to screening for postmenopausal osteoporosis. Report of a WHO Study Group. World Health Organ Tech Rep Ser 1994;843:01-129. PMID: 7941614.
9. Parfitt AM, Gallagher JC, Heaney RP, Johnston CC, Neer R, Whedon GD. Vitamin D and bone health in the elderly. Am J Clin Nutr 1982;36:1014–31. DOI: 10.1093/ajcn/36.5.1014.
10. Aguado P, del Campo MT, Garcés MV, González-Casaús ML, Bernad M, Gijón-Baños J, et al. Low vitamin D levels in outpatient postmenopausal women from a rheumatology clinic in Madrid, Spain: Their relationship with bone mineral density. Osteoporos Int 2000;11(9):739-44. DOI: 10.1007/s001980070052.

11. Heidari B, Hosseini R, Javadian, Y. Bijani A, Sateri MH, Nouroddini HG. Factors affecting bone mineral density in postmenopausal women. Arch Osteoporos 2015;10(1):15. DOI: 10.1007/s11657-015-0217-4.
12. Demir B, Haberal A, Geyik P, Baskan B, Ozturkoglu E, Karacay O, et al. Identification of the risk factors for osteoporosis among postmenopausal women. Maturitas 2008; 60(3-4):253–56. DOI: 10.1016/j.maturitas.2008.07.011.
13. Heidari B, Jalali F. Bone densitometry in rheumatoid arthritis. Acta Med Iran 2005; 43(2):99–104.
14. Mezquita-Raya P, Muñoz-Torres M, Luna JD, Luna V, Lopez-Rodriguez F, Torres-Vela E, et al. Relation between vitamin D insufficiency, bone density, and bone metabolism in healthy postmenopausal women. J Bone Miner Res 2001;16(8):1408-15. DOI: 10.1359/jbmr.2001.16.8.1408.
15. Villareal DT, Civitelli R, Chines A, Avioli LV. Subclinical vitamin D deficiency in postmenopausal women with low vertebral bone mass. J Clin Endocrinol Metab 1991; 72(3):628–34. DOI: 10.1210/jcem-72-3-628.
16. Gloth FM, Gundberg CM, Hollis BW, Haddad JG, Tobin JD. Vitamin D deficiency in homebound elderly persons. JAMA 1995;274:1683–86. DOI: 10.1001/jama.1995.03530210037027.
17. Haden ST, Fuleihan GEH, Angell JE, Cotran NM, LeBoff MS. Calcidiol and PTH levels in women attending an osteoporosis program. Calcif Tissue Int 1999; 64(4):275–79. DOI: 10.1007/s002239900618.