RESEARCH ARTICLE

Comparison of vitamin D levels with bone density, calcium, phosphate and alkaline phosphatase — an insight from major cities of Pakistan

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Abstract

Objectives: To compare vitamin D levels with bone mineral density, serum calcium, phosphorous and alkaline phosphatase.

Methods: The cross-sectional multicentre study was conducted at Pakistan Health Research Council centres in Islamabad, Lahore, and Karachi, and comprised subjects coming for either vitamin D testing or bone mineral density examination. Information related to demography, height/weight, skin colour, smoking, use of sun screen, daily milk intake, sun exposure and exercise was taken along with biochemical tests like serum calcium and phosphorous, alkaline phosphatase, and 25 hydroxy vitamin D. Bone mineral density was done using dual-energy X-ray absorptiometry scan. SPSS 15.0 was used for data analysis.

Results: Of the 291 subjects, 100(34.3%) each were enrolled from Islamabad and Lahore, while 91 (31.2%) were from Karachi. Overall, 245(84%) had insufficient vitamin D which was significantly associated with age and dark skin colour ($p<0.05$ each). Besides, 137(48%) cases had a reduced bone density, and there was a significant difference between age groups, gender and skin colour ($p<0.05$ each).Vitamin D deficiency did not have any effect on bone mineral density ($p>0.05$) Serum calcium and phosphorus levels were also similar regardless of vitamin D level ($p>0.05$).

Conclusion: Vitamin D deficiency did not have any direct impact on bone mineral density and serum calcium, phosphorous and alkaline phosphatase.

Keywords: Vitamin D, Pakistan, Dexa Scan, Correlation, Bone mineral density. (JPMA 68: 543; 2018)

Introduction

Vitamin D plays a key role in homeostasis as well as regulation of body functions and its deficiency has been associated with different disorders.[1] Vitamin D deficiency is reported in different age brackets and in different age groups, like newborns, toddlers, pregnant women, adolescents, and elderly males from different countries.[2-4] The common risk factors of vitamin D deficiency are poverty, not taking proper diet, poor calcium intake, dark pigmented skin, avoiding sunlight and social norms such as indoor living.[5-7] it has been reported that despite abundance of sunlight in South Asia, there is vitamin D insufficiency.[8,9] The deficiency of vitamin D is a public health issue in Pakistan and its prevalence in different areas of Pakistan ranges from 70% to 90% in healthy asymptomatic volunteers, while 92-97% deficiency was reported in ambulatory patients.[10,11]

Insufficient vitamin D results in increased bone loss and low bone mineral density (BMD)[12,13] as well as osteoporosis.[14-16] However, it was shown that vitamin D deficiency has no direct impact on BMD.[16,17] Keeping in view this high vitamin D deficiency prevalence in Pakistan, the current study was planned to assess whether this deficiency has direct impact on BMD of local population or not, and to correlate its deficiency with serum phosphorous, calcium and alkaline phosphatase.

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Subject and Methods

The cross-sectional multicentre study was conducted in 2015-16 at Pakistan Health Research Council (PHRC) centres in Islamabad, Lahore, and Karachi, and comprised subjects coming for either vitamin D testing or BMD examination. Initially, the PHRC centre at Faisalabad was also part of the plan but due to some technical issues, it was dropped, after approval from the institutional bioethics committee, participants, who gave written informed consent were enrolled.

A sample size of 384 was calculated on the basis of 50% prevalence with 95 confidence interval and 5% margin of error by using following formula: n= Z2p (1-p)/e2. The calculated sample size was equally distributed into four cities but after Faisalabad was dropped, enrolment was done from Islamabad, Lahore and Karachi.

Non-probability convenient sampling technique was used to enrol the subjects from among those who were coming for either vitamin D testing or BMD examination. Those taking vitamin D supplementation, multivitamins, calcium (Ca), undergoing chemotherapy or steroid therapy, and those suffering from hypo/hyper thyroidism,

cancer bone tumours or malabsorption were excluded, and so were pregnant females.

A pre-designed proforma was used to collect information on demography, skin colour, smoking, use of sun screen, daily milk intake, sun exposure and exercise etc. Body mass index (BMI) was calculated using the standard formula i.e. weight in kilogrammes divided by square of height in meters. The physical activity was defined as per the World Health Organisation (WHO) criteria.[18]

Biochemical tests performed included alkaline phosphatase (ALP), serum calcium, serum phosphorus, and 25 hydroxy vitamin D(25[OH]D). Serum phosphorous, calcium and ALP were determined by spectrophotometric method, while 25(OH)D was determined by using radioimmunoassay method.

BMD was determined at two sites i.e. lumbar spine and hip by Dual-Energy X-ray absorptiometry (DEXA) scanning for adults. The subjects were categorised into normal, osteoporosis, osteopenia as per WHO recommendations.[18] BMD was calculated based on normal reference values for gender and age-matched subjects as provided by the manufacturer.

The T-score was calculated as a difference between the BMD of the subjects and BMD of the expected normal young man divided by the population standard deviation (SD). Osteoporosis was categorised as T < -2.5 and osteopenia was defined as T between-1 and 2.5.[19]

Data was entered into Microsoft Excel and analysed using SPSS 14.0. Relationship and comparison was done using Chi-square test and $p<0.05$ was considered significant.

Results

Of the 291 subjects, 100(34.3%) each were enrolled from Islamabad and Lahore, while 91 (31.2%) were

Table-1: Association of Demographic characteristic with vitamin D levels and bone mineral density.

Demographic features	Sufficient Vit. D	Insufficient Vit. D	P-value	Normal BMD	Reduced BMD	P-value
Age Group (years)						
≤ 19	2	27	0.01	24	5	< 0.00001
20-44	17	129		90	56	
45 and Above	27	89		40	76	
Gender						
Male	19	96	0.78	71	44	0.01
Female	27	149		83	93	
BMI						
Normal	20	95	0.38	61	54	0.41
Overweight	10	68		36	42	
Obese	16	65		46	35	
Under weight	0	17		11	6	
Skin color						
Dark	25	63	0.001	32	56	0.001
Fair	11	95		63	43	
Wheatish	8	62		43	27	
Use of sun screen						
Yes	1	9	0.679	7	3	0.184
No	36	209		119	126	
Daily Milk Intake						
No milk	20	115	0.845	61	74	0.051
<1 glass	1	4		3	2	
1 - 2 glass	25	121		87	59	
Daily Sun Exposure						
None	16	39	0.079	25	30	0.490
< 5 minutes	0	12		7	5	
5-15 minutes	8	38		23	23	
15-30 minutes	7	54		27	34	
> 30 minutes	15	89		59	45	
Daily Exercise						
Little or No Exercise	27	138	0.11	86	79	0.53
Light Exercise	7	71		44	34	
Moderate Exercise	9	25		15	19	
Hard Exercise	3	11		9	5	

Table-2: Comparison of vitamin D deficiency with bone mineral density (BMD) and serum Calcium, Phosphate and ALP.

Description		Sufficient vitamin D (n=46)	Insufficient vitamin D (n=245)	P-value
Dexa Scan (Adults)	Normal	21 (48%)	109 (50%)	0.853
	Osteopenia	18 (41%)	80 (37%)	
	Osteporosis	5 (11%)	29 (13%)	
Dexa Scan Children	Normal	2	22	0.542
	Low	-	5	
Ca	Normal	19 (41.3)	68 (27.7)	0.142
	Low	27 (58.6)	175 (71.4)	
	High	-	2 (0.8)	
PO4	Normal	39 (84.7)	208 (84.8)	0.991
	Low	4 (8.6)	21 (8.5)	
	High	3 (6.5)	16 (6.53)	
ALP	Normal	38 (82.6)	195 (79.5)	0.638

DEXA: Dual-energy X-ray absorptiometry.
Ca: Calcium.
PO4: Phosphorus.
ALP: Alkaline phosphotase.

from Karachi. Overall, there were 115(39.5%) males and 176(60.5%) females. Of the total, 245(84%) had insufficient vitamin D. No significant difference for gender, milk intake, BMI, exercise and daily sunlight was found ($p>0.05$). However, there was a significant difference for age group and skin ($p<0.05$ each). Overall, 154 (53%) subjects had normal BMD. In normal and reduced BMD group, there was a significant difference for gender, age groups and skin colour ($p<0.05$ each). No significant difference for use of sunscreen, milk intake, BMI, daily sun exposure and daily exercise was found (Table-1). Among the 147(48%) subjects who had reduced bone density, 98(66.6%) had osteopenia and 34(23%) had osteoporosis. Osteoporosis was more in females 28(19%) than males 6(9%). Calcium was low in 202 (69%) cases, ALP was high in 58(20%) cases, while phosphorous was low in 26(9%) and high in 20(7%).

Comparison of vitamin D levels with BMD showed there was no significant difference for those who had either normal or reduced BMD ($p>0.05$). Similarly, normal, low and high values of Ca, phosphorous and ALP had no significant difference in vitamin D sufficient and insufficient groups (Table-2).

Discussion

The findings showed that 84% of the study population had insufficient vitamin D level, but BMD of almost 50% participants was almost normal. Vitamin D deficiency is commonly reported in Asia and has been reported from different countries and associated risk factors are inadequate, improper and timing of sun exposure, diet and genetics.[3,5,10,11,20]

Vitamin D insufficiency as found in this study is similar to other studies conducted in Pakistan.[11,14,21] Dark skin colour was a significant risk factor associated with vitamin D insufficiency which is consistent with the studies conducted in South Asia.[17,22,23]

The BMD examination showed that almost half of the study population had a normal bone minerals level. But on the other hand, one quarter had osteopenia and other quarter had osteoporosis, indicating that almost half of the population is on the risk of bone fracture. Osteopenia and osteoporosis were common among females, especially of old age. This was consistent with a previous study.[24]

Our study findings showed no correlation between vitamin D levels with the BMD, which is similar to the findings reported by others.[25,26] Studies have also reported a positive association between vitamin D levels and BMD at the hip and spine in men and women.[12,27,28] Another study from India on healthy individuals also reported similar results.[16] However, this is contradictory to the findings from the same population of South Asian women living in the United Kingdom where serum 25(OH)D

deficiency was associated with a progressive reduction in bone mass.[17] Other studies also reported a varying effect of vitamin D deficiency on BMD.[25,29,30]

Vitamin D is an essential component and plays different role in the body involving gene regulation and homeostasis, especially bone density. However, the reported vitamin D deficiency in almost every population of world indicates that probably either the assay being used for its estimation are not correct or there are some other precursors of vitamin D. Similarly, it was also reported that vitamin D administration has no effect on the absorption of calcium in adult Pakistani population[31] and reported that there is a possibility that maximal vitamin D-dependent Ca absorption was already achieved even at a low vitamin D level.

Keeping in view the sample size and sampling technique of the study, the findings cannot be generalised and there is a need to do a nationwide study.

Conclusion

No direct relation of vitamin D deficiency with decreased BMD and levels of phosphorus, serum calcium, and ALP was seen which suggested that probably our population had adjusted with low vitamin D levels.

Disclaimer: None.

Conflict of Interest: None.

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