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Research Article

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The impact of vitamin D deficiency on bone mineral density at different age groups: a Middle Eastern and Asian cohort

Abstract

Objectives: This is a pilot study to evaluate the skeletal consequences of the vitamin D deficiency in a big cohort of patients who are Vitamin D naïve. Primarily we aimed to assess the effect of vitamin D deficiency on the BMD. Secondarily, we wanted to correlate the low vitamin D and the risk of osteopenia and osteoporosis in different age and gender groups.

Methods: This is a retrospective study that analyzed patients who checked their vitamin D between 2007-2015. Age, gender, vitamin D level, serum calcium, creatinine, whether patient is receiving renal replacement therapy or not and bone mineral density scan (DEXA).

Results: Total number of patients included was 2587 patients. Overall osteopenia was 47.5% of female's n=907, while 24.0% of men n=459 had it. But, osteoporosis was in 24.1% n=459 of females, versus 32.2% n=218 of males with a p= of 0.00. 28% of males had normal BMD n=544, and 28.55% of females n=544. Osteoporosis was in >50-years age (78% of those who had osteoporosis). 26% of those who underwent DEXA scan had osteoporosis n=677, 47% had osteopenia n=1216, and 28% had normal BMD n=694 to have normal BMD. At the age of 20-50 years; 36% had normal BMD, 16.8% and 24.2% had osteoporosis and osteopenia, respectively, with a p- value of 0.000.

Conclusion: Our studies have shown female predominance of osteopenia plus osteoporosis together, but male's predominance in the osteoporosis alone. Elder lies had higher rates of osteoporosis. After clearance of the confounding factors, female gender, age >50 years, serum calcium <8 and vitamin D level <10ng/ml are all considered as independent risk factors of osteoporosis.

Keywords: vitamin D deficiency, United Arab Emirates, UAE, osteoporosis, DEXA, bone mineral density

Volume 3 Issue 4 - 2016

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Received: September 07, 2016 | **Published:** October 03, 2016

Introduction

Global prevalence of Hypovitaminosis D has opened a new horizon of research for its numerous health-related adverse effects. However, historically vitamin D deficiency has a major impact on musculoskeletal health and manifest as rickets in children and osteomalacia in adults.[1]

Due to the growing prevalence of vitamin D deficiency, there is an increasing risk of osteomalacia and osteoporosis, especially in the areas with very high rates of vitamin D deficiency like in UAE with high prevalence of vitamin.[2]

Osteoporosis is the major risk factor for fragility fractures which themselves are associated with high morbidity and mortality. An individual risk of developing osteoporosis depends on his peak bone mass. Which is defined as the maximum bone mass and strength achieved at the end of growth period, usually 18 years in girls, and 20 years in boys? It is influenced by many factors some of them are non-modifiable like genetic, endocrine influence. While some risks are modifiable determinants like nutritional, intake of vitamin D, calcium, and physical activity.[3]

Out of all available diagnostic tools for assessment of bone density and architecture, so far the most widely used procedure is dual-energy x-ray absorptiometry (DEXA) assessment for diagnosis of osteoporosis, and monitoring the progress over time.[4]

Many studies have shown that patients with osteomalacia secondary to vitamin D deficiency have reduced bone mineral density[5,6] though it does not differentiate between osteomalacia from osteoporosis, a study by Massoud Saghafi and his group concluded that bone densitometry can detect osteomalacia as osteoporosis in 70% of cases.[7]

Thus it is important to see relationship of bone densitometry changes with vitamin D level, for earlier diagnosis of low bone mass and early administration of vitamin D instead of anti-bone resorptive therapy for treatment. It can also help in determining that cut off value of vitamin D, where bone density start to decline.

Our study has been conducted in an area with a very high prevalence of vitamin D deficiency, Middle East, having known that, we think the awareness of the consequences of this terrifying prevalence should be thoroughly assessed. This study is a pilot study designed to evaluate the skeletal consequences of the vitamin D deficiency in a big cohort of patients who are Vitamin D naive.

Patients and methods

Objectives

Primarily we aimed to assess the effect of vitamin D deficiency on the BMD. Secondarily, we wanted to correlate the low vitamin D and the risk of osteopenia and osteoporosis in different age and gender groups.

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Study design and population

This is a retrospective study that has been conducted in Dubai Health Authority, Dubai, United Arab Emirates.

We included all patients who had their 25(OH) D checked during the period of 2007 to 2015, and at the same period they had all the other parameters mentioned below. All data were transferred into a data collection form. Variables included demographic, clinical and laboratory characteristics. The parameters that have been included were age, gender, vitamin D level, serum calcium, creatinine, whether the patient is receiving renal replacement therapy or not and bone mineral density scan (DEXA).

Calcium and vitamin D were chosen to be the first ever tested figures in the DHA facilities. The BMD chosen were any BMD scan that has been done within 6 month of the primary vitamin D level. This leaves a minor percentage of patients who might have received the vitamin D supplementation from private institutes. Since the renal jeopardy affects the BMD; we calculated the impaired creatinine level as a confounding factor while analyzing the set of data.

Definitions

Vitamin D deficiency was defined as a 25(OH) D below 20 ng/ml, insufficiency as a 25(OH) D of 21-29 ng/ml, and sufficiency as a 25(OH) D of 30-100 ng/ml in accordance with the guidelines of The Endocrine Society, USA.[8]

Normal BMD= T-score >-1, Osteopenia= T-score -1 to -2.5, Osteoporosis= T-score <2.5.

Data analysis

Data analysis was performed on SPSS software 16.0. In all analysis, a p-value <0.05 was considered significant and P < 0.001 considered highly significant. Quantitative variables were described as mean; standard deviation (SD) and range, qualitative were described as variables as number and percentage. We have used the Chi-square test to compare qualitative variables between groups. The unpaired t-test was used to compare quantitative variables, in parametric data (SD <50 % mean). Binary logistic regression analysis was used to find out significant independent factors and to exclude confounding factors.

Results

In our study, the total number of patients included was 2587 patients. 87.7% of them were females (n=2270) and 12.3% were males (n=317). 107 of them were below 20 years of age, 661 were 20-50-year-old, and 1819 patient was above the age of 50 years. Overall osteopenia was 47.5% of female's n=907, while 24.0% of men n=459 had it. But, very much against expectation, osteoporosis was encountered in 24.1% n=459 of females, in comparison to 32.2% n=218 of males with a p-value of 0.00. Normal BMD was found in 28% of males n=544, and 28.55 of females n=544 (Figure 1).

Concerning the age variable versus the BMD, osteoporosis was highest shown in the above 50 years age group (78% of those who had osteoporosis). 26% of those who underwent DEXA scan had osteoporosis n=677, 47% had osteopenia n=1216, and only 28% turned to have normal BMD n=694 to have normal BMD. At the age of 20-50 years; 36% had normal BMD, 16.8% and 24.2% had osteoporosis and osteopenia, respectively, with a p-value of 0.000 (Table 1).

Interestingly, Vitamin D did not show statistical significance when it was correlated to the BMD, only 15.7% of the total osteoporosis cases had vitamin D level <10ng/ml, and 13.2% of the total osteopenia patients had vitamin D level 10-30ng/ml, and that brought up a p-value of 0.54 when compared to those who had normal vitamin D indices (Table 2). Upon further analysis, low vitamin D was strongly correlated particularly to the Z score of the spine, but that was the case with neither spine T score nor pelvis T and Z scores. In contrast to the age, this showed a highly significant correlation to all the scores except the T-score of the spine (Table 3).

Age is a known risk factor for osteoporosis. Upon binary logistic regression analysis, age>50 years, vitamin D <10nmol/dl, female gender, and calcium of <8mg/dl, all of them proved to be a sensitive independent risk factor, without having two risk factors at a time (Table 4).

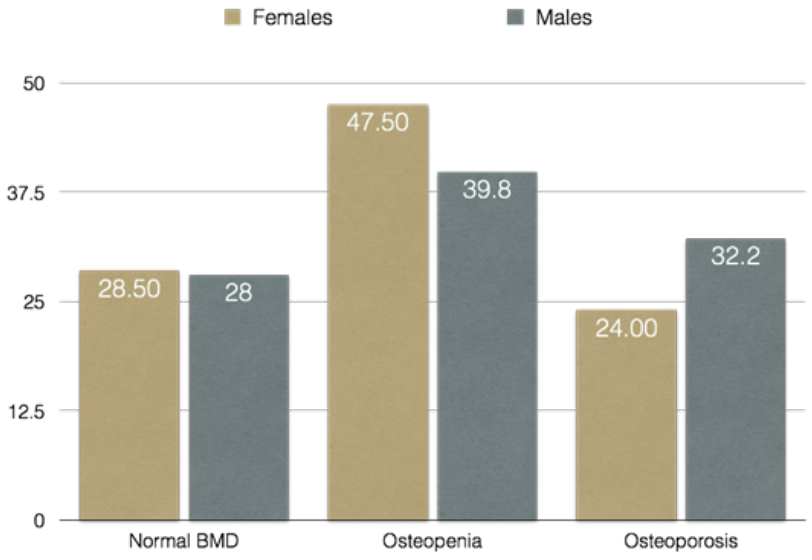

Figure 1 This figure shows a higher percentage of osteoporosis in males but less osteopenia and comparable normal BMD.

Citation: Abdelgadir EIE, Basheir AMK, Rashid F, et al. The impact of vitamin D deficiency on bone mineral density at different age groups: a Middle Eastern and Asian cohort. *Endocrinol Metab Int J.* 2016;3(4):79–83. DOI: 10.15406/emij.2016.03.00054

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Table 1 Relation between BMD results versus age groups

Variables	BMD			X^2	P
	Normal	Osteoprosis	Osteopenia		
<20yrs	17 (2.4%)	35(5.2%)	55(4.5%)		
20-50	253(36.5%)	114(16.8%)	294(24.2%)	74	0.000 HS
>50	424(61.1%)	528(78%)	867(71.3%)		

This table shows that normal BMD were more frequent among the age group 20-50 compared to osteoporosis and osteopenia and lower frequencies of these abnormalities among younger age group with a statistically significant association between by using chi-square test.

Table 2 Relation between vitamin D levels versus BMD

Variables	BMD			X^2	P
	Normal	Osteoprosis	Osteopenia		
<10	104(15.1%)	106(15.7%)	160(13.2%)		
10-30	451(65.3%)	417(61.9%)	765(63.1%)		
30-75	120(17.4%)	136(20.2%)	261(21.5%)	6.9	0.54 NS
75-100	9(1.3%)	9(1.3%)	17(1.4%)		
>100	7(1%)	6(0.9%)	10(0.8%)		

This table shows no statistically significant association between Vit-D level versus BMD results by using chi-square test.

Table 3 Correlation between vitamin D levels versus BMD parameters

	Vit D	
BMD score	**r**	**p**
T-score pelvic	0.01	0.44
Z-score pelvic	0.03	0.24
T-score spine	0.04	0.23
Z-score spine	0.10	0.02S
BMD score	**Age**	
	r	**p**
T-score pelvic	-0.14	0.0002HS
Z-score pelvic	0.23	0.0000HS
T-score spine	0.03	0.40
Z-score spine	0.24	0.0000HS

This table shows statistically significant positive correlation between Vit D versus Z score spine. Statistically, significant positive correlation between age versus Z score pelvis and spine and inverse correlation versus score spine by using Spearman correlation test.

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Table 4 Relation between different risk factors versus BMD by logistic regression

Variables	Beta-coefficient	p	Odd's (95%CI)
Calcium <8mg/dl	0.02	0.002	1.5(0.3-18,9)
Age >50	-0.04	0.04	1.1(0.1-11)
Vit D<10	-0.21	0.001	1.02(0.3-14.6)
Female sex	0.11	0.05	1.09(0.1-13.6)

This table shows that calcium level, age, gender and vitamin D level were considered independent predictors of BMD status by using binary logistic regression.

Discussion

Our result showed highly significant prevalence of osteopenia and osteoporosis in males and females, irrespective of their age. A very interesting finding is that males were having more osteoporosis rates than females. Though many previous studies showed female osteoporosis predominance. Researchers have attributed this finding to their nutritional habits, long dressing, lack of weight bearing exercise and effect of menopause [9].

It has been observed by Guzle et al.,[10] veiled premenopausal women compare to non-veiled women have reduced Z score in lumbar spine and low vitamin D.[10] Although men with osteoporosis were numerically less than females, but the percentage was statistically significant p=0.000. This could be explainable by the selectivity towards men, females are more prone to do DEXA scan in comparison to males. Another observation in our study is the high prevalence of osteoporosis in subjects older than 50 years, as 78% of them were found to have osteoporosis. This finding is also a globally observed fact.[11-13]

Our result demonstrated, 16.8% subjects belonging to middle aged group and 5.8% of younger population had osteoporosis, but surprisingly the level of vitamin D <10 ng/ml was only found in 15.7 %,while vitamin D insufficiency (10-29ng/ml) was found in 13% of all of those cases. This association is of no statistic significance. The lack of strong association of vitamin D with BMD changes has been observed in many studies before. In a prospective study, Stone K et al.,[9] measured calcareous and hip BMD at baseline and few years later on follow up, in 9704 white women of 65 year and older age group, and they did not find significant association of low vitamin D with bone loss.[14] Another study done by Ghannam et al in young Saudi females showed similar findings like our study in terms of osteoporosis prevalence, but they found no strong association of BMD with low vitamin D.[15]

However, some studies showed contrary findings, as one study by Sadat et al.,[16] showed a strong association of osteopenia and osteoporosis in patients with vitamin D deficiency though in a smaller cohort than ours.[16] Similarly Bischoff-Ferrari et al.,[17] also observed a positive correlation between low vitamin D and low BMD in a population of different age groups. The heterogeneous result may be due to number of reasons like most of them are retrospective and carries the inherent risk of bias by not recording individual risk of low bone mass, dietary habits, exercise, nutritional survey, family history of osteoporosis.

Limitation of the study

This study is a huge retrospective analysis on the vitamin D and the bone mineral density. However, it carries limitations of being a retrospective analysis of data that we already had in the electronic health system.

Conclusion

In conclusion, the results of our study have shown that female predominance of osteopenia plus osteoporosis together, but male's predominance in the osteoporosis alone. Vitamin D was not statistically correlated to the occurrence or the severity of osteoporosis. Elder lies had higher rates of osteoporosis. After clearance of the confounding factors, female gender, age >50 years, serum calcium <8 and vitamin D level <10ng/ml are all considered as independent risk factors for osteoporosis. Further prospective studies need collaboration of the clinical governance and clinical researchers to prevent osteoporosis risks.

Acknowledgments

None.

Conflicts of interest

The author declares there are no conflicts of interest.

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