

## Original Research Article

# A study on vitamin D status among orthopaedic patients

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**Received:** 02 December 2019

**Revised:** 04 January 2020

**Accepted:** 05 January 2020

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### ABSTRACT

**Background:** There is an alarmingly high prevalence of hypovitaminosis D in orthopaedic patients, regardless of whether or not, they require surgical intervention. Vitamin D plays an essential role in bone formation, maintenance, and remodelling, as well as muscle function and deficiency could affect adversely in multiple ways. Many reports recently demonstrated high rates of vitamin D deficiency, in numerous segments of Indian population, but there is no study reported so far from India, which focuses specifically on vitamin D status in orthopaedic patients.

**Methods:** It is a descriptive study to estimate vitamin D levels in patients scheduled to undergo orthopaedic surgery. Vitamin D, calcium, phosphorus and alkaline phosphatase (ALP) levels in 310 patients, who were admitted at our institution, from December 2015 to August 2017 were measured.

**Results:** Out of 310 patients included in our study, 189 (61%) were males and 121 (39%) females. Vitamin D deficiency (<20 ng/ml) was present in 232 patients, insufficiency (<30 ng/ml) was present in 63 patients and only 15 patients had desirable levels (>30 ng/ml). Patients younger than 60 years and males had more prevalence of Vitamin D abnormality. 168 (72.4%) of the patients, with deficiency presented in winter, compared to 64 (27.6%) in summer.

**Conclusions:** Statistically significant vitamin D deficiency was seen during winter months, in patients undergoing hip hemiarthroplasty, and in patients admitted for degenerative disease of the spine, hip and knee. Screening and treating hypovitaminosis D appears to be important in orthopaedic patients as vitamin D deficiency is prevalent across all age groups in the population studied.

**Keywords:** Vitamin D deficiency, Orthopaedic patients, India, Prevalence

### INTRODUCTION

Vitamin D, also known as the antirachitic factor, or the sunshine vitamin, plays a vital role in bone health and muscle function. Chronic vitamin D deficiency leads to osteoporosis, osteomalacia, muscle weakness, osteoarthritis, nonspecific backache, generalized body ache, increased risk of fracture due to trivial falls.<sup>1</sup>

Vitamin D deficiency has been seen in all races, age groups, and ethnic backgrounds and it is estimated to affect >1 billion people worldwide.<sup>1</sup> A systematic review

from India in 2014 by Ritu et al vitamin D deficiency prevails in epidemic proportions all over Indian sub-continent with a prevalence of 70–100% in the general population.<sup>2</sup> In studies in Saudi Arabia, the United Arab Emirates, Turkey, India and Lebanon, 30 to 50% of children and adults had 25-hydroxyvitamin D (25(OH)D) levels under 20 ng/ml.<sup>3</sup>

Despite these reports on the prevalence of hypovitaminosis D in the general population, there is a paucity of studies focusing on orthopaedic surgery patients. Moreover, while the majority of studies of this nature have involved postmenopausal women with

fragility or hip fractures, to our knowledge, no studies to date have described the prevalence of hypovitaminosis D in the adult orthopaedic population, irrespective of age or sex. Given the critical role of vitamin D in musculoskeletal health and function as well as the potential negative consequences of vitamin D deficiency in the operative and postoperative settings, data revealing the prevalence of vitamin D deficiency in this patient population may be of value.

The objectives of the study were to evaluate serum levels of vitamin D, calcium, phosphorus, and alkaline phosphatase in patients, scheduled to undergo orthopaedic surgery and co-relate the levels of vitamin D among various types of orthopaedic surgical patients, as well as to assess seasonal variations of vitamin D levels.

## METHODS

This descriptive study was conducted on 310 patients above 18 years of age, not taking vitamin D and calcium supplements for last 6 months, scheduled to undergo orthopaedic surgery admitted to the Department of Orthopaedics, St. John's Medical College Hospital, Bangalore from December 2015 to August 2017.

Pregnant women, patients with known malabsorption syndromes, on drugs like anticonvulsants, thiazide diuretics, steroids, bisphosphonates, oestrogen or progesterone or selective estrogen receptor modulator, and hepatic, renal, parathyroid diseases were excluded.

Blood samples for serum 25(OH) vitamin D, calcium, alkaline phosphate and phosphorus was collected from the subjects by venepuncture, observing all safety, and under aseptic precautions. The sample was centrifuged and cell-free supernatant was aliquoted and stored at -20° C until assayed.

Serum vitamin D was estimated using Elecsys Precicontrol Varia® (Cobas), serum calcium using Siemens Dimensions® clinical chemistry system, serum phosphorus using Siemens Dimensions® clinical chemistry system, and serum alkaline phosphatase (ALP) was measured using dimension clinical chemistry system (EXL 1 & EXL 2) from Siemens. The normal ranges accepted under this study are depicted in Table 1.

**Table 1: Biological reference range.**

Parameter	Range
Calcium	8.5-10 mg/dl
Phosphorous	2.5-4.9 mg/dl
Vitamin D	Deficient <20 ng/ml
	Insufficient 20-30 ng/ml
	Desirable >30 ng/ml
Alkaline phosphatase	46-116 IU/l

Descriptive statistics and statistical software (SPSS 18.0) were used for the analysis of the data. Analysis of variance (ANOVA), chi-square or Fisher exact test have been used to find the significance of study parameters. Significance is assessed at 5 % level of significance.

## RESULTS

310 patients comprising 189 (61%) males, and 121 (39%) females with mean age of 46.2 (18-80 yrs) years formed the cohort. Vitamin D deficiency (<20 ng/ml) was present in 232 patients (74.8%); 63 patients (20.3%) had insufficient vitamin D level (20-30 ng/ml) and only 15 patients (4.8%) had sufficient levels of vitamin D. Age and gender distribution of the Vitamin levels are depicted in Table 2. Patients younger than 60 years and males had more prevalence of vitamin D abnormality.

Seasonal variation in vitamin D deficiency was indicated by the 168 patients (72.4%) found to be deficient in the winter season, compared to the 64 patients (27.6%) found to be deficient in summer. No patient sampled during the winter season had desirable levels of the vitamin. This seasonal variation was statistically significant ( $p \leq 0.01$ ) (Table 3).

Under arthroscopy specialty, 51 patients (16.5%) underwent knee arthroscopy (for anterior cruciate ligament or posterior cruciate ligament reconstruction and/or meniscus repair/balancing), out of which 38 (74.5%) were deficient in vitamin D and only 1 (1.9%) of them had sufficient levels of the sunshine vitamin and 22 patients (7.1%) underwent arthroscopic rotator cuff repair, of whom 18 (81%) were deficient (Table 4 and 5).

In trauma category, 47 of the 64 patients with upper limb fractures, 65 of the 88 patients with lower limb fractures and 5 of the 8 vertebral fracture patients were deficient in vitamin D.

18 patients (5.8%) underwent total knee replacement (TKR) surgery while 12 patients (3.9%) underwent total hip replacement (THR) surgery for degenerative disease of the respective joints. 9 patients (2.9%) warranted hemiarthroplasty for fractured neck of femur. Amongst the total number of patients with vitamin D deficiency, 13 (5.6%) belonged to the TKR group and 9 patients (3.9%) belonged to THR group, 4 patients (1.7%) belonged to hemiarthroplasty group. These patients were further categorized under "Arthroplasty" speciality. Vitamin D deficiency in patients undergoing hemiarthroplasty of the hip was found to be statistically significant ( $p \leq 0.01$ ).

39 patients (12.6%) were taken up for spine surgery as a result of degenerative disease of the spine which included inter-vertebral disc prolapse (IVDP) and lumbar canal stenosis (LCS), 33 of which were deficient in vitamin D.

Total 120 patients (51.7%) operated in view of alleged road traffic accident (RTA) were deficient in vitamin D

levels while 34 patients (14.7%) who were admitted with a history of trivial fall/self-fall were deficient. It was observed that 13 (5.6%) patients with sports injury were deficient in vitamin D and 4 (6.3%) had insufficient vitamin D levels. A statistically significant ( $p \leq 0.01$ )

distribution was observed with deficient vitamin D in 65 patients (28%) admitted as a result of degenerative disease of spine/hip/knee while only 3 patients amongst them had desirable vitamin D levels (Table 6).

**Table 2: Comparison of age and gender distribution of patients studied in relation to vitamin D levels.**

Variables	Vitamin D levels			Total (n=310) N (%)	P value
	Deficient (n=232) N (%)	Insufficient (n=63) N (%)	Desirable (n=15) N (%)		
	<b>Age in years</b>				
0-20	8 (3.4)	2 (3.2)	0 (0)	10 (3.2)	0.249
20-60	171 (73.7)	42 (66.7)	8 (53.3)	221 (71.3)	
61-80	53 (22.8)	19 (30.2)	7 (46.7)	79 (25.5)	
<b>Gender</b>					
Female	91 (39.2)	24 (38.1)	6 (40)	121 (39)	0.984
Male	141 (60.8)	39 (61.9)	9 (60)	189 (61)	

**Table 3: Seasonal distribution of patients studied in relation to vitamin D levels.**

Season	Vitamin D levels			Total N (%)
	Deficient N (%)	Insufficient N (%)	Desirable N (%)	
	<b>Summer</b>	64 (27.6)	49 (77.8)	
<b>Winter</b>	168 (72.4)	14 (22.2)	0 (0)	182 (58.7)
<b>Total</b>	232 (100)	63 (100)	15 (100)	310 (100)

$P < 0.001$ , significant, chi-square test.

**Table 4: Group distribution of patients studied in relation to vitamin D levels.**

Group	Vitamin D levels			Total N (%)	P value
	Deficient N (%)	Insufficient N (%)	Desirable N (%)		
	<b>Knee arthroscopy</b>	38 (16.4)	12 (19)		
<b>Trauma fore arm</b>	35 (15.1)	9 (14.3)	5 (33.3)	49 (15.8)	0.443
<b>Spine surgery</b>	33 (14.2)	5 (7.9)	1 (6.7)	39 (12.6)	0.319
<b>Trauma leg</b>	25 (10.8)	4 (6.3)	2 (13.3)	31 (10)	0.529
<b>Trauma proximal femur</b>	15 (6.5)	6 (9.5)	3 (20)	24 (7.7)	0.138
<b>Shoulder arthroscopy</b>	18 (7.8)	4 (6.3)	0 (0)	22 (7.1)	0.508
<b>Total knee replacement</b>	13 (5.6)	3 (4.8)	2 (13.3)	18 (5.8)	0.428
<b>Trauma ankle foot</b>	12 (5.2)	3 (4.8)	1 (6.7)	16 (5.2)	0.956
<b>Total hip replacement</b>	9 (3.9)	3 (4.8)	0 (0)	12 (3.9)	0.691
<b>Trauma proximal humerus</b>	9 (3.9)	1 (1.6)	0 (0)	10 (3.2)	0.507
<b>Hemiarthroplasty</b>	4 (1.7)	5 (7.9)	0 (0)	9 (2.9)	0.027*
<b>Trauma shaft femur</b>	7 (3)	1 (1.6)	1 (6.7)	9 (2.9)	0.562
<b>Trauma spine</b>	5 (2.2)	3 (4.8)	0 (0)	8 (2.6)	0.415
<b>Trauma distal femur</b>	3 (1.3)	2 (3.2)	0 (0)	5 (1.6)	0.506
<b>Trauma distal humerus</b>	2 (0.9)	1 (1.6)	0 (0)	3 (1)	0.808
<b>Trauma patella</b>	3 (1.3)	0 (0)	0 (0)	3 (1)	0.601
<b>Trauma shaft humerus</b>	1 (0.4)	1 (1.6)	0 (0)	2 (0.6)	0.567
<b>Total</b>	232 (100)	63 (100)	15 (100)	310 (100)	-

\*Significant p values.

**Table 5: Speciality distribution of patients studied in relation to vitamin D levels.**

Speciality	Vitamin D levels			Total N (%)	P value
	Deficient	Insufficient	Desirable		
	N (%)	N (%)	N (%)		
Trauma	120 (51.7)	31 (49.2)	11 (73.3)	162 (52.3)	0.231
Arthroscopy	56 (24.1)	16 (25.4)	1 (6.7)	73 (23.5)	0.281
Spine	33 (14.2)	5 (7.9)	1 (6.7)	39 (12.6)	0.319
Arthroplasty	23 (9.9)	11 (17.5)	2 (13.3)	36 (11.6)	<0.001*
<b>Total</b>	232 (100)	63 (100)	15 (100)	310 (100)	-

\*Significant p values.

**Table 6: Cause distribution of patients studied in relation to vitamin D levels.**

Cause	Vitamin D Levels			Total N (%)	P value
	Deficient	Insufficient	Desirable		
	N (%)	N (%)	N (%)		
RTA	120 (51.7)	32 (50.8)	8 (53.3)	160 (51.6)	0.982
Degenerative	65 (28)	12 (19)	3 (20)	80 (25.8)	<0.001*
Self-Fall	34 (14.7)	15 (23.8)	4 (26.7)	53 (17.1)	0.139
Sports	13 (5.6)	4 (6.3)	0 (0)	17 (5.5)	0.616
<b>Total</b>	232 (100)	63 (100)	15 (100)	310 (100)	-

\*Significant p values.

## DISCUSSION

Vitamin D deficiency has been seen in all races, age groups, and ethnic backgrounds and it is estimated to affect >1 billion people worldwide.<sup>1</sup> Vitamin D deficiency is endemic in India.<sup>4</sup> Numerous reports have highlighted the low levels of vitamin D noted in various spectrum of the population, including young adults, the elderly population and postmenopausal women.<sup>5-9</sup> All the prospective studies, however, have analysed healthy subjects. To the best of our knowledge, no study has been reported so far from India, which focuses specifically on vitamin D status among orthopaedic surgery patients.

We estimated a high prevalence of vitamin D deficiency in this cohort of orthopaedic patients admitted in our institution. We found that vitamin D deficiency (<20 ng/dl) was present in 74.8% patients and 20.3 % patients had insufficient vitamin D levels (20-30 ng/dl) and only 4.8% patients had desirable levels of vitamin D. These results are comparable with those of similar studies investigating the prevalence of vitamin D deficiency in orthopaedic surgery patients in USA and Germany with a vitamin D deficiency prevalence of 40% and 60% respectively.<sup>10</sup> Zellner et al found that 86.2% of orthopaedic in-patients were insufficient in 25-hydroxyvitamin D (<30 ng/ml), 53.2% were deficient (<20 ng/ml), and 14.0% had levels <10 ng/ml.<sup>11</sup>

The 232 patients with hypovitaminosis D in our study comprised of 141 men (60.8%) and 91 women (39.2%). A retrospective study performed by Bogunovic et al of 723 orthopaedic patients showed that the prevalence of low vitamin-D levels was significantly higher in men.<sup>10</sup> Zolfaghari et al concluded from their

study that in 110 patients with degenerative diseases of the spine, women showed significantly higher levels of vitamin D compared to men.<sup>12</sup>

Our study showed a significant increase in the prevalence of hypovitaminosis D during the winter months than during the summer months with greater sunshine hours. Similar seasonal variation was reported by Maier et al who investigated the extent of hypovitaminosis D in the German orthopaedic population.<sup>13</sup> In a retrospective observational cohort study conducted by Bee et al at a level 2 trauma centre, the average level for the winter cohort was 26.4 ng/ml, which was significantly lower than the average level for the summer cohort, 29.8 ng/ml.<sup>14</sup>

Our study showed that out of the 39 patients, who underwent spine surgery, 84.6% were deficient and 12.8% had insufficient vitamin D levels. Stoker et al conducted a retrospective investigation of preoperative vitamin D deficiency among adults undergoing spinal fusion.<sup>15</sup> The rates of inadequacy (<30 ng/ml) and deficiency were 57% and 27%, respectively. A study by Kim et al in 350 patients with lumbar canal stenosis in an orthopaedic outpatient clinic concluded the prevalence of hypovitaminosis D to be 74.3%.<sup>16</sup> Zolfaghari et al showed that in 110 patients with degenerative diseases of the spine about to undergo spinal surgery, 44.5% of patients showed vitamin D deficiency (<20 ng/ml), with an additional 17.3% of patients having a serum level of 25-(OH)D that was insufficient (20 ng/ml to 30 ng/ml).<sup>12</sup>

44% of the patients in our study who underwent hemiarthroplasty of the hip had a significant vitamin D deficiency and 55% of them had insufficient levels. A

retrospective comparative study conducted by Johnson et al at 2 level 2 trauma centres and 2 community hospitals in San Diego, California, showed that in patients with hip fractures of all ages showed, 65.8% were deficient in vitamin D.<sup>17</sup> High prevalence (76.7%) of hypovitaminosis D was reported in a study conducted by Dhanwal et al, which included patients with hip fractures in North India.<sup>18</sup>

Among the orthopaedic specialities, the highest rates of deficient vitamin-D levels were seen in the spine surgery (84.6%) and arthroscopy (76.7%) specialities in our study. Significant vitamin D deficiency was observed in 63.9% patients undergoing arthroplasty surgery while 30.6% had insufficient levels. Goula et al concluded in their study that majority of patients scheduled to undergo total joint replacement (hip/knee arthroplasty) were vitamin D deficient (81.7 %); 15.2% of them were vitamin D insufficient. Only 3% of patients were vitamin D sufficient.<sup>19</sup>

75% of the patients operated as a result of injury due to alleged RTA were deficient in vitamin D levels while 64.2% of the patients who were admitted with a history of trivial fall/self-fall were deficient. It was observed that 76.5% of patients with sports injury were deficient in vitamin D and 23.5% had insufficient vitamin D levels. A significant vitamin D deficiency was observed in 65 patients (81.3%) admitted as a result of degenerative disease of spine/hip/knee while only 3 patients amongst them had desirable vitamin D levels.

## CONCLUSION

In conclusion, there is an alarmingly high prevalence of vitamin D deficiency and insufficiency, across all age groups among the orthopaedic patients. Statistically significant vitamin D deficiency was seen during winter months than during summer, in patients undergoing hip hemiarthroplasty and in patients admitted as a result of degenerative disease of the spine, hip and knee. There was a direct positive correlation between vitamin D and ALP. This study aims to generate awareness amongst health-care professionals regarding high prevalence of vitamin D deficiency in orthopaedic patients and the need for screening of all orthopaedic patients for hypovitaminosis D. There is a need for a multi-centric study within the Indian subcontinent to get the big picture of the actual burden of vitamin D deficiency among orthopaedic patients in our part of the world. The study did not assess vitamin D deficiency and post-operative functional outcome in the patients.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the institutional ethics committee, St. Johns Medical College & Hospital*

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**Cite this article as:** Santhanagopal S, Sebastian M, Muniswamy MM, Pilar A. A study on vitamin D status among orthopaedic patients. *Int J Res Orthop* 2020;6:286-91.