



Endocrinology Committee of FOGSI



## Vitamin D and Bone Health

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India is Osteoporotic Capital in the world with 1 out of 8 males and 1 out of 3 females in India suffer from osteoporosis <sup>1</sup> . There has been a drastic increase in osteoporosis cases over the last decade. In 2013, approximately 36 million people affected from osteoporosis as compared to 26 million in 2003. Osteoporotic fractures occur 10-20 years earlier than in western countries.

Osteoporosis is a progressive chronic disorder that affects the bone by decreasing the bone density and deteriorating the bone microarchitecture. This makes the bones porous and fragile leading to fractures (FIG 1). Osteoporosis is one of the major health concerns in India.



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**FIG 1: A: Normal bone B: Osteoporotic bone (Porous)**



## Magnitude of problem

Being the second most populous country, coupled with increasing longevity and a decreasing age at menopause, India is becoming the osteoporosis capital of the world. In India, widely prevalent Vitamin D deficiency, underdiagnosis in high risk individuals and delay in treatment initiation have led to the increased burden of this disease. The exact prevalence of osteoporosis is not known as it is grossly under reported. A few Indian studies place the incidence between 25%- 62%. Hip fractures are the most dreaded sequelae of osteoporosis. It is estimated that 1 in 3 women, over the age of 50, has an osteoporotic fracture. Approximately, 20% of women over 60 years of age die within 1st year of having a hip fracture. It is thus, a serious health risk causing significant mortality and economic burden for postmenopausal women.

Vitamin D deficiency is the main culprit for osteoporosis. In India, this silent epidemic is only worsening. The prevalence of vitamin D deficiency has been difficult to estimate as different studies use different cut-off values for vitamin D levels, but majority of the studies have reported a prevalence of 80%–90%.<sup>1</sup> A recent IOF report on the global status of Vitamin D nutrition highlights South Asia (especially India) as one of the most deficient regions.

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## Vit D and bone health

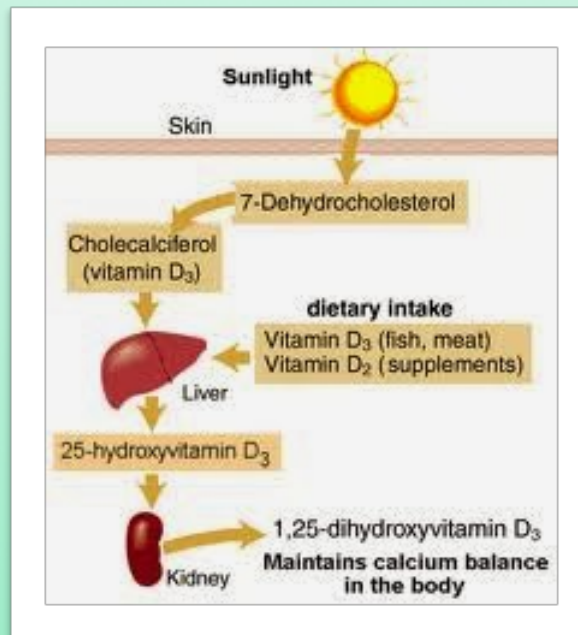
The role of vitamin D in bone metabolism has been known and studied over the years. It is now considered as a pro hormone than as a vitamin. Vitamin D, favours reabsorption of calcium and phosphorus at the renal and intestinal level thereby, maintaining their homeostasis. There are various manifestations of vitamin D3



deficiency. It reduces calcium absorption, alteration of bone mineralization and compensatory rise in parathyroid hormone (PTH), causing excessive bone resorption. This leads to rickets in children and osteomalacia in adults.

Dietary intake of calcium coupled with adequate exposure to sunlight is needed to achieve good bone mass. The bone mass peaks at around the 3rd decade of life and there after it progressively declines, approximately at the rate of 1%- 2% per year. The cortical bone loss is accelerated in postmenopausal women. There is rapid trabecular bone loss superimposed with slow cortical bone loss. To decrease this bone loss, an optimal level of vitamin D should be maintained.

Vitamin D is photosynthesized in the skin on exposure to ultraviolet B rays of wavelength 290–320 nm (FIG 2).



**FIG 2: Synthesis of vitamin D**

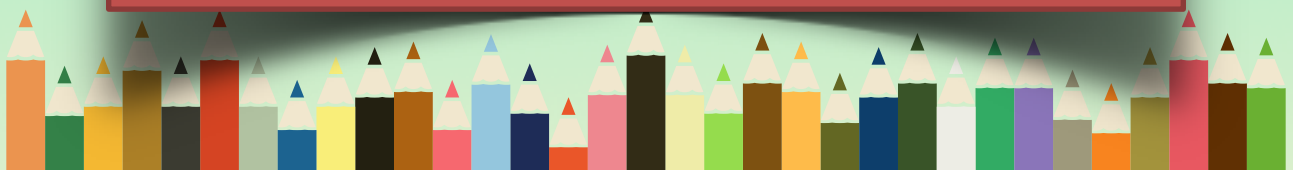
Nutrition plays a key role in bone health. Main dietary sources are full cream milk, fish, fortified food, and supplements. A traditional Indian vegetarian diet does not provide even 10% of the required daily dose of vitamin D. Vitamin D deficiency is widespread in India, despite



ample exposure to sun as that alone is not sufficient for vitamin D production. There are other factors that influence vitamin D production which are summarised in Table 1.

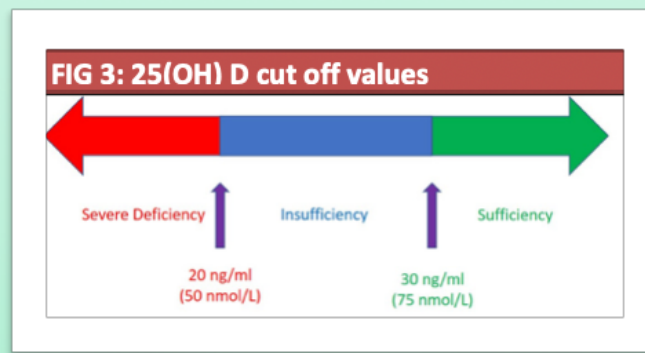
**Table 1: Factors influencing vitamin D production**

- Exposure to sunlight, which itself is variable and affected by;
- Skin pigmentation
- Clothing
- Use of sunscreen
- Atmospheric pollution
- Latitude
- Use of sunscreen
- Age (conversion of 7- dehydrocholesterol to vitamin D3 is inversely proportional with age)
- Absence of vit D fortified foods, traditional Indian vegetarian diet
- Genetic factors leading to vitamin D deficiency
- Baseline vitamin D level
- Intestinal absorption rates, renal or liver insufficiency
- Type and form of vitamin D supplementation
- Medications interfering with vitamin D metabolism



## Assessing vitamin D levels

The 25(OH)D serum levels are the recommended method to assess the Vitamin D status. The Endocrine Society of India defines 25(OH)D levels  $>30$  ng/ml (75 nmol/L) as adequate for most of the population and may provide greater benefit for individuals presenting with conditions such as osteoporosis. Serum 25(OH)D concentrations below 20 ng/ml have been associated with a higher risk of osteoporotic hip fractures, vertebral, wrist and proximal humerus fractures.



## Recommended daily allowance (RDA) of Vitamin D

There is a paucity of standardised guidelines for Indian population regarding the RDA. The ICMR guidelines needs an urgent revision as the RDA advised is much less than actually needed.) International Osteoporosis foundation (IOF ) recommends that seniors aged 60 years and take a supplement at a dose of 800 to 1000 IU/day. Vitamin D supplementation at these levels has been shown to reduce the risk of falls and fractures by about 20%. As per the US Endocrine Society guidelines following are the RDA of Vit D:





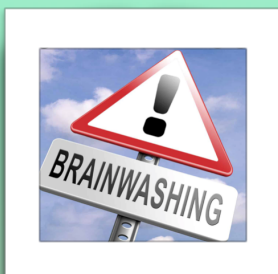
**Table 2: RDA of Vitamin D, US Endocrine**

Life stage group	RDA (IU)	Upper limit
Adults (18 years and above)	1,500-2,000	10,000
Pregnancy and lactation	1,500-2,000	10,000
Children and adults at risk*	2-3 times the normal requirement for their age	

\*At risk: Obesity, HIV infection, on glucocorticoids, anticonvulsant, antifungal, and antiviral therapy; A desirable range is between 30 and 60 ng/mL, although levels up to 100 ng/mL are unlikely to result in vitamin D toxicity; Except in granuloma disorders, wherein it is advisable to maintain the serum levels of 25 (OH)D upto >30 ng/mL; RDA: Recommended daily allowance

**Available preparations of vitamin D3**

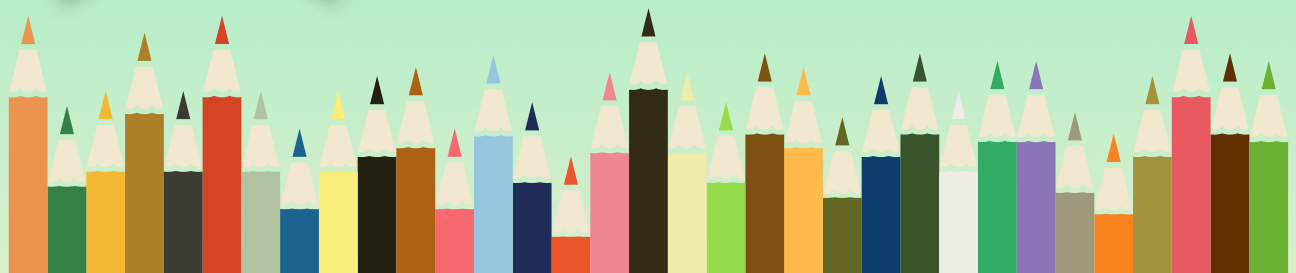
Various formulations of vitamin D are available in the market (Table 3). Intramuscular injections are cost-effective may be recommended in cases of malabsorption and to increase compliance, but being an oil-based injection, it is painful can produce erratic blood levels. New delivery system known as Nano-emulsion or micellized preparations are available for fat soluble vitamin A, D, E, K etc. They disperse fatty substances into microscopic, water soluble and micellar spheres enabling them to reach absorptive surfaces of intestinal tract facilitating maximal absorption and improving bio availability of vitamin D



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 COULD YOU BE AT RISK OF OSTEOPOROSIS AND FRACTURES?



Dose for



<b>Form of Vitamin D</b>	<b>Dosage</b>
Cholecalciferol (Oral tablets, capsules, granules, syrup)	1000 IU, 2000 IU, 60,000 IU
Cholecalciferol oral sprays	1000 IU/spray
Intramuscular	300,000 IU and 600,000 IU per ampoule

## Toxicity

Dose for the treatment should not exceed 4000/day and hypercalcemia and hypercalciuria has been reported with doses of 10,000 IU/day.

## Management of Vitamin D deficiency

- Exposure to sunlight remains the primary source of vitamin D. It is preferable to get vitamin D through sunlight by exposing 15 to 30% of body surface area (face, neck and both arms and forearms) without sunscreen for at least 30 minutes between 11 AM and 3 PM. This is equivalent to consuming 340- 490 IU of vitamin D every day
- Government of India, in a recently updated health policy, has addressed the fortification of food as a key strategy to tackle the growing burden of vitamin D deficiency. It has permitted voluntarily fortification of milk with 200- 300 IU of vitamin D2 ergocalciferol in 1L of milk and 4.4- 6.4 IU of vitamin D2 per gram of vegetable oil (Food safety and standards regulation, 2018). This would enable an intake of 30 to 50% i.e. 200 to 300 IU of recommended daily allowance of vitamin D assuming consumption of milk/milk product per day is 700 ml and oil 30 ml per day.



- Supplementation with vitamin D

Since, intake from the natural sources have its limitations, it is recommended to use vitamin D as supplements. Cholecalciferol (Vitamin D3) is the preparation of choice. It has been found to increase bone density, decrease bone turnover, and decrease nonvertebral fractures. Various studies recommend, a dose of 600 IU/day for women between 1 and 70 years and for those over 70 years as 800 IU/day. An intake of 500-2000 IU/day, for women > 65 years, has been found to decrease the chance of hip fracture and any non-vertebral fracture. The doses vary according to the degree of deficiency, the patient's age, and the presence of risk factors. As a practical rule, it can be predicted that for every 100 IU supplemented, there is an increase of 0.7–1.0 ng/mL in the concentration of 25(OH)D.

Routine supplementation with calcium 1000 mg per day is recommended as mandatory or adjunct therapy. Several studies have documented synergistic affect with vitamin D and calcium supplementation in preventing proximal femur and fractures in postmenopausal and older patients.<sup>3,4</sup>

100 IU of vitamin D intake will raise serum 25(OH) D by 1ng/ml.

 **WOMEN OVER 50 WILL EXPERIENCE**   
**OSTEOPOROTIC FRACTURES. AS WILL**  **MEN.**





Table 4 summarizes the recommendations of the Indian Menopause Society for vitamin D supplementation.

Table 4: IMS recommendations for management of deficiency

**Therapeutic dose:**

- Cholecalciferol vitamin D3 tablet or powder 60 K IU once a week for eight weeks preferably with milk or,
- One intramuscular injection of 60 K IU, not to be repeated before 3 months

**Maintenance therapy:**

- Cholecalciferol tablet or powder 60 K IU once a month in the summer or twice a month in winter
- Oral spray/tablets of 2000 IU per day or
- Injection 30 K IU IM, twice a year/ 60 K IU intramuscular once a year

## Conclusion

### 'Prevention is better than cure'

Focus on active & healthy lifestyle & adequate sunlight exposure.<sup>6</sup>

Fortification of food with Vitamin D is the key strategy

Revision of RDA for Vitamin D by ICMR is much needed

Vitamin D supplements of good quality should be made available for population at risk

Educational programs to create awareness about Vitamin D

Testing facilities for Vitamin D levels should be made affordable and accessible to those at high risk as mass screening is not feasible

Government funded research to study and monitor the impact of supplementation programs and fortification strategies.

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