

## Vitamin D Deficiency: Facts and Figures

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### ABSTRACT

**Introduction:** Vitamin D is also called the sunshine vitamin. This study relates to the deficiency of vitamin D in bone related complaints and disease. Vitamin D deficiency may occur due to inadequate sun exposure or diet. Eggs, milk are good sources of vitamin D.

Vitamin D receptors are expressed in brain, heart, skin, gonads, cardiomyocytes, vascular endothelial cells, vascular smooth muscle cells and kidney cells. It is a hormone and a vital amine. It is involved in smooth muscle cell proliferation, thrombosis, and fibrinolysis and vessel relaxation. It has role in preventing cardiovascular disease.

**Methods:** Vitamin D or 25 hydroxy D3 levels were estimated in serum sample of patients with bone related complaints over 7 months duration. Calcium, phosphate, Para hormone, Alkaline phosphatase, CRP, ferritin were also measured for clinical correlation.

**Results:** It was observed that especially during the winter months and in post covid era, patients complaining of bone related symptoms showed a deficiency or insufficiency of vitamin D levels which is the precursor of active vitamin D. Vitamin D is an immunomodulator and if we supply vitamin D in food like eggs and milk, exposure to sunshine, supplemented with calcium rich diet such as milk, green leafy vegetables, meat, the loss can be recovered with improvement of symptoms.

**Conclusion:** In patients with low back pain, knee pain, heel pain, or other bone related symptoms, and in post covid era for improved immunity it is advisable that vitamin D intake be adequate to meet the requirement of body. Diet and sunshine are natural ways to boost vitamin D usage in the body. Calcium and phosphorous intake in elderly and arthritis patients should be adequate in the form of milk, eggs, meat.

**Keywords:** 25-hydroxy D3, 1,25dihydroxy D3, Calcium, Phosphorous, Parathormone, Deficiency, Sunshine, Milk, Egg, Meat, Alkaline phosphatase, Deficiency, Pain

### INTRODUCTION

Vitamin D is a hormone as well as a vitamin. Vitamin D is a fat soluble vitamin derived during cholesterol synthesis. Cholesterol gets converted to 7 dehydrocholesterol or ergosterol is acted upon by ultraviolet light to form secosterol or provitamin D 3 which is further converted to isomerize from cis to a trans double bond to form vitamin D 3 or cholecalciferol. So vitamin D is called the sunshine vitamin [1].

In winter months when the wavelength of UV rays from sunlight shift to longer wavelengths vitamin D deficiency manifests as skin cannot synthesize enough vitamin D3 from sunlight.

Vitamin D receptors are expressed in brain, heart, skin, gonads, cardiomyocytes, vascular endothelial cells, vascular smooth muscle cells and kidney cells. It is involved in smooth muscle cell proliferation, thrombosis, fibrinolysis

and vessel relaxation. It has role in preventing cardiovascular disease.

Vitamin D receptors, VDR, form heterodimer complex with Retinol X receptor, RXR. This complex binds to Vitamin D response elements, VDRE, of DNA and influence transcription.

Vitamin D acts on the intestinal villi to absorb calcium. Vitamin D promotes the absorption of calcium.

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Calcitriol stimulates osteoblasts to synthesize alkaline phosphatase enzyme. This enzyme increases the local concentration of phosphate. The ionic product of calcium and phosphate thus increases leading to bone mineralization.

Active Vitamin D or calcitriol helps reabsorb calcium and phosphorous from renal tubules. Parathyroid hormone helps in absorption of only calcium.

Regulation of calcitriol or active vitamin D is by calcium, phosphorous, parathormone and calcitriol itself. The regulatory checkpoint is at the  $\alpha 1$  hydroxylation at the proximal convoluted tubule of renal tubules.

Low calcium or phosphate will activate  $1\alpha$ -hydroxylase. Hypocalcaemia increases parathormone levels which in turn increases synthesis of dihydroxy cholcalciferol, DHCC which is further hydroxylated to calcitriol. DHCC regulates PTH. Half-life of DHCC is 6-8 h and is excreted in bile. Inactivation of DHCC is by oxidation of side chain or 24 hydroxylation.

Vitamin D toxicity due to excess exposure to sunrays does not occur in nature because excess provitamin D3 and Vitamin D3 are destroyed by sunrays. Feedback system is operating such that toxic levels of vitamin D3 are not generated on natural exposure to sunlight in the skin [2].

Commercial vitamin D is derived from the fungus ergot. The ergosterol when treated with ultraviolet light forms ergocalciferol or vitamin D2. Ergocalciferol differs in having a double bond in the side chain and a methyl group at C 28 [3].

A hormone is a chemical secondary messenger and biological active substance that are produced in minute quantities and are carried by blood to distant organs at their site of function. In this way vitamin D is a prohormone. Vitamin D is involved in immunity. Activation of vitamin D and up regulation of genes is the basis of increasing antimicrobial proteins in the body and enhanced immunity [4].

Gaps in the knowledge related to usefulness and excess use-Vitamin D tablet and calcium supplements are prescribed very commonly to patients for various bone related complaints, vitamin D deficiency or for women's general health. But how far is it worthwhile? Does it cause any toxicity if taken for prolonged period in high doses? What is the benefit of prescribing vitamin D and Calcium prescription? Does it recover from knee pain, arthritic pain, joint pains, low back pain, carpal pain, brittle bone, osteoporosis, osteomalacia, bone fractures which the elderly are prone to, or for those who do not get enough sunlight exposure due to cold climatic conditions or clothing patterns of covering from head to toe or staying indoors in air conditioned rooms? [4].

Vitamin D estimations are carried out for investigational purpose, for undermining the evidence for bone related

symptoms, for special checkups with suspected symptoms, malabsorption, liver and renal diseases when the hydroxylation reactions are retarded [5].

Some sources of vitamin D are egg yolk, sunlight on skin, fish liver oil, milk [6].

Rich sources of calcium are milk, egg, fish, and vegetables. Cereals contain small amount of calcium. But being a staple diet, they form the main source of calcium in Indian diet.

Requirement of vitamin D is 5  $\mu\text{g}$  or 200 IU/day for adults. For children, pregnancy, lactation, requirement is 10  $\mu\text{g}/\text{day}$  or 400IU/day. For elderly, requirement is  $\mu\text{g}/\text{day}$  12.5  $\mu\text{g}/\text{day}$  or 600 IU/day.

Treatment of osteoporosis requires 1000 IU/day or 50000 IU/week. For treating obese children 800 IU/day is required vitamin D gets stored in the adipose tissue and retrieval is difficult.

Requirement for calcium in diet is 500mg/day in adults and 1200mg/day in children and elderly. They are abundant in egg, fish, and vegetables.

Requirement for phosphorous in diet is 500mg/day. Milk is a good source which contains 100mg/dl of phosphates. Cereals, nuts, meat are other sources.

Treatment- The softness of joints that occur in adults due to insufficient exposure to sunlight and spending maximum time in closed air conditioned room or during prolonged winter months can be cured by supplement of vitamin D [7].

Those elderly with concomitant kidney diseases need supplement of calcitriol or the active form of vitamin D.

End organ refractoriness, such a cytosolic receptor deficiency or abnormal receptor also responds to calcitriol or active vitamin D.

## METHOD

Vitamin D and Calcium were assayed on 250 cases and controls. Assay was performed on auto analyzer Access 2, Beckman coulter immunoassay system using ELISA, CLIA, ECIQ techniques. Three Level quality control and specific calibration were run in the Access 2 machine for vitamin D estimation.

Calcium level was estimated in Beckman Coulter automated analyzer AU 480, reference ranges for deficient, insufficient, sufficient, toxic levels of vitamin D were established for the deficient levels of vitamin D are  $<20$  ng/ml, Insufficient 21- $<30$  ng/ml, Sufficient 32-100ng/ml, Upper sufficient limit  $>100$ ng/ml. Levels  $>150$  ng/ml are toxic.

It was a cross sectional descriptive case control study. Study period was 7 months duration; data analysis is based on collected data from July 2022 to January 2023 based in a clinical biochemistry laboratory. Sample size was 1500; prevalence of vitamin D deficiency was taken 26.7%. The

assay was done to measure the serum level of cholecalciferol or 25(OH) D3 and measure the outcome in various bone related disorders as given in the case history.

Calcium estimation was carried out in AU 480 auto analyzer by indirect ion selective method.

Some other tests included were alkaline phosphatase enzyme assay, (ALP levels). Parathormone or iPTH levels and phosphate estimation for correlation.

Inclusion criteria- Patients of all age groups with bone related complaints, chronic kidney disease, pediatric patients, immunocompromised patients, cancer patients, critically ill patients or general complaints in whom vitamin D estimation were done were subject to the study.

Exclusion criteria - Unrelated complaints.

## RESULTS

The age group of patients selected for the study were 18 years or older, both males and females who attended the outpatient department or were admitted to ward in a tertiary care center of India.

The major complaints were low back pain, knee pain, carpal pain, heel pain, neck pain with radiculopathy, spondylosis, spondylolisthesis, diabetes, chronic kidney disease, old cerebrovascular accident with low back pain. The occupation of such patients was different factory related work.

Vitamin D was deficient or insufficient in majority patients with bone related complaints.

Vitamin D was also deficient in chronic kidney disease patients and immune compromised patients.

Ferritin levels, i PTH levels were also high in chronic kidney disease patients.

Alkaline Phosphatase levels were high in some cases of deficient or insufficient levels of Vitamin D.

Calcium levels were low normal or slightly low.

Phosphate was normal to high.

C- reactive protein, CRP was also high.

Out of 1500 vitamin D estimations in patients complaining of related symptoms, 406 patients were found to have deficient or insufficient level of vitamin D. 27 percent patients were suffering from vitamin D deficiency of some form, either acute or chronic at the time of testing.

In the summer months the vitamin D deficiency is less than that in winter because of exposure to sunlight in India which is helps in natural synthesis of vitamin D.

## DISCUSSION

With the ongoing covid pandemic people have become susceptible to repeated flu like symptoms; sneezing, cold, body aches and pains, malaise, feeling unwell [8].

These may affect the immune status of patients and may contribute to the vitamin D deficiency prevalence and morbidity of patients [9]. It has been advocated that the prevailing situation of covid, people should consume more vitamin D, vitamin C containing diet for boosting immunity [10-12].

It is generally advocated to have a balanced diet and have vitamin D levels in the reference range of 30-100 ng/ml, taking care that excess supplements may cause toxic levels of vitamin D which is not advisable [11,13,14]. Symptoms include weakness, polyuria, excess thirst, difficulty speaking, hypertension, weight loss, hyperkalemia causing deposition of calcium in kidney and blood vessels called calcinosis [10].

## CONCLUSION

Vitamin D is an immunomodulator, a hormone and a vital amine. Its intake should be adequate and to optimize it, it is advised to consume more egg, milk, exposure to sunshine. In elderly intake of calcium and phosphorous as in milk and eggs will supplement the vitamin D replenishment.

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