

Review

Article

## Vitamin D deficiency and Its health consequences – A review

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The world is currently facing an unrecognized and untreated pandemic of Vitamin D Deficiency (VDD)<sup>1</sup>. VDD is a significant public health problem in both developed and developing countries, including India<sup>2</sup>. It is highly prevalent across all age groups. Vitamin D (VD) is a prehormone that humans obtain from foods and dietary supplements and by endogenous skin synthesis from 7-dehydrocholesterol with sunlight exposure<sup>3</sup>. The present article reviews the etiology of VDD, physiological functions and sources of VD, health consequences and prevalence of VDD in different regions of India.

### Physiological Functions of Vitamin D

It has long been known that VD plays important role in bone development and calcium homeostasis<sup>4</sup>. Beyond bone integrity and calcium homeostasis, VD is involved in various physiological and pathological processes<sup>5</sup>. VD has many non-calcaemic functions, among which are immune functions<sup>6</sup>, endocrine functions, cardiovascular functions, neuro-psychological functions, neuromuscular performance and anticancer actions<sup>7-13</sup>. VD plays an important role in immunological disease through reduced activation of acquired immune system<sup>14-19</sup>. It also works as an inducer of cellular differentiation to protect against carcinogenesis<sup>12,13</sup>. VD acts as a potent antioxidant to protect against free radical damage. It also plays crucial role in prevention from infectious disease through enhancement of the innate immune system<sup>20-26</sup>.

### Etiology of VDD

Risk factors for developing VDD include low maternal levels of VD, indoor confinement of children during the day, living in urban areas with tall buildings, atmospheric pollution, darker skin pigmentation, low exposure to sun, less amount of skin exposed and use of sunscreen<sup>27</sup>. Dietary factors like low calcium intake and high fibre diet may also deplete VD stores. Genetic factors like increased 25(OH)D-24 Hydroxylase activity also lead to VDD in sunny countries<sup>28</sup>.

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### Sources of VD

The major source of VD for our body is cutaneous synthesis through the effect of ultraviolet B radiations on 7-dehydrocholesterol. Vitamin D<sub>2</sub> (ergocalciferol) and Vitamin D<sub>3</sub> (cholecalciferol) are the two main forms of VD. Vitamin D<sub>2</sub> (ergocalciferol) obtained from influence of ultraviolet B radiation on plants and yeasts and Vitamin D<sub>3</sub> (cholecalciferol) produced in skin by ultraviolet radiation<sup>2</sup>. VD is present mainly in fatty fish, cod liver oil, organ meat, egg yolk and milk products<sup>3</sup>.

### Health Consequences of VDD

VDD is a risk factor for many disorders right from conception to entire lifespan<sup>2</sup>. VDD results in development of rickets in children<sup>29</sup>. It also leads to predisposition to lower respiratory tract infection, which is one of the main causes of child mortality<sup>27</sup>. Scientific evidences have shown that VDD has detrimental effects on bone mineral acquisition<sup>30,31</sup> and bone remodeling<sup>32,33</sup> amongst children and adolescent. In adults, VDD precipitates and exacerbates both osteopenia and osteoporosis and increases the risk of fracture<sup>34-37</sup>. It is associated with skeletal mineralization defect<sup>29</sup>, proximal muscle weakness and an increased risk of falling<sup>38-40</sup>. VDD increases the risk of autoimmune diseases (Type I diabetes, multiple sclerosis, rheumatoid arthritis, inflammatory bowel disease), cardiovascular diseases, infectious diseases like urinary tract infection and tuberculosis, common cancers, hypertension, obesity and type II diabetes. It also affects the fetal health and exercise performance<sup>2</sup>.

### Prevalence of VDD in India

VDD is a major health problem in India despite abundant sunshine<sup>41</sup>. It is highly prevalent across all age groups from earlier infancy to late adulthood<sup>2</sup>. Studies conducted in different regions of the country have revealed that VDD is highly prevalent in children, adolescents, adults and in elderly groups. The prevalence of VDD among all age groups in different regions of India has been depicted in table 1.

**Table 1:** Prevalence of Vitamin D Deficiency in India

Authors	Year	Location	Age	CB / HB	Sample Size	Prevalence (%) of VDD (Serum 25(OH) D <20ng/ml)	Cut off levels considered to Define VDD	Ref.
Prevalence of VDD amongst Children <5 Years of Age								
Jain V et al	2011	New Delhi	0-3 mo	HB	98	86.5%	<20ng/ml	4
Wayse V et al	2004	Pune	2mo–5 yrs	HB	70	61.4%	<20ng/ml	27
Prevalence of VDD amongst Children 5–<18 Years of Age								
Marwaha RK et al	2010	Delhi	6-17 Years	CB	124 (LSES)	97.5%	<20 ng/ml	42
					166 (USES)	90.9%		
Borkar VV et al	2010	Chandigarh	6-12 years	HB	50	32%	<20ng/ml	43
Sahu M et al	2009	Lucknow	10-20 years	CB	121	88.6%	<20 ng/ml	44
Puri S et al	2008	Delhi	6-18 years	CB	193 (LSES)	89.6%	<20 ng/ml	45
					211 (USES)	91.9%	<20 ng/ml	
Marwaha RK et al	2005	Delhi	10-18 years	CB	430 (LSES)	92.6%	<20 ng/ml	46
					330 (USES)	84.9%	<20 ng/ml	
Prevalence of VDD amongst adults aged 18–<50 years								
Shivane KV et al	2011	Mahar- ashtra	25-35 years	CB	1137	62% (M)	<20 ng/ml	47
						76% (F)		
Goswami Ret al	2008	Uttar- Pradesh	>18 years	CB	57	68.5%	<20ng/ml	41
Zargar AH et al	2007	Kashmir	18-40 years	CB	92	83%	<20ng/ml	48
Harinarayan CV et al	2007	Andhra Pradesh	NA	CB	943 (urban)	62% (M)	<20 ng/ml	49
						75% (F)		
					205 (rural)	44% (M)		
						70% (F)		
Harinarayan CV et al	2004	Andhra Pradesh	NA	CB	316	69.3%	<20 ng/ml	50
Arya V et al	2004	Lucknow	NA	HB	92	78.3%	<20 ng/ml	51
Prevalence of VDD amongst Population aged 50 years and above								
Marwaha RK et al	2011	Delhi	>50 year	CB	1346	91.2%	<20ng/ml	52
Paul VT et al	2008	Tamil Nadu	≥50 year	CB	150	49.5%	<20 ng/ml	53
Harinarayan CV et al	2005	Andhra Pradesh	≥50 years	CB	164	82%	<20 ng/ml	54

Abbreviations: - CB-community based, HB-Hospital based, Mo-months, LSES-Low socio economic strata, USES-Upper socio economic strata, M-Male, F-Female, NA-Not available

### Cut off levels to Define VDD

Presently, serum 25 (OH) D is the best indicator for the diagnosis of VDD<sup>2</sup>.

The cut off's utilized to define vitamin D status are depicted in table 2.

**Table 2 Cut offs Utilized to Define Vitamin D Deficiency<sup>55</sup>**

Vitamin D status	Serum 25(OH)D level (ng/ml)
Deficiency	<20ng/ml
Mild	10-20ng/ml
Moderate	5-10ng/ml
Severe	<5ng/ml

**Conclusion:**

The present review was undertaken to document VDD among different age groups of India. VDD is a significant public health problem in India in spite of adequate sunshine. VDD is equally prevalent in lower and higher socio-economic groups. Studies have documented that VD has many non-skeletal effects and correction of VDD lowers the risk of many long latency diseases like cancers, autoimmune disease and cardiovascular disease. It also decreases the risk of infectious disease and improve fetal health, muscle function and exercise performance. There is a need of developing strategies for VD supplementation to reduce prevalence of VDD amongst population.

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