

# Prevalence of vitamin D deficiency in higher socioeconomical class of Ahmedabad, Gujarat, India

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## Abstract

**Background:** Vitamin D is a group of fat-soluble secosteroids responsible for intestinal absorption of calcium and phosphate. Vitamin D is a major player in calcium homeostasis and bone metabolism. In humans, the most important compounds of vitamin D are vitamin D<sub>2</sub> (ergocalciferol) and vitamin D<sub>3</sub> (cholecalciferol). Most of the vitamin D<sub>3</sub> is synthesized in skin when it is exposed to ultraviolet B rays from sunlight. Vitamin D deficiency causes osteomalacia in adults and rickets in children. Deficiency of vitamin D results in impaired bone mineralization and bone damage, which leads to bone-softening diseases.

**Objective:** To find out the prevalence of vitamin D deficiency in well socioeconomic population of Ahmedabad, Gujarat, India.

**Materials and Methods:** This is a cross-sectional study, carried out among the higher socioeconomic populations of various age and sex in Ahmedabad City, Gujarat, India. In this study, all the 444 subjects included were tested for serum 25(OH)D level by the electro-chemiluminescence immunoassay (ECLIA) method using an automated clinical chemistry analyzer (Elecsys 2100; Roche Diagnostics).

**Results:** In this study, majority (46.4%) of the subjects were severely deficient, while 39.9% were moderately deficient. Hence, more than 85% of the subjects were moderate to severely deficient.

**Conclusion:** Serum vitamin D level estimation must be done in health-care management of skeletal disorders and nutritional review status. Serum 25(OH)D is the best measure of vitamin D exposure indicating both the effects of diet and sunlight. Severity of vitamin D deficiency also increases with the age.


**KEY WORDS:** Cholecalciferol, vitamin D<sub>3</sub>, 25(OH)D

## Introduction

Vitamins are organic compounds that are required in minute quantities to sustain life. Vitamin D comprises a group of fat-soluble secosteroids responsible for intestinal

absorption of calcium and phosphate. Vitamin D was long known to be a major player in calcium homeostasis and bone metabolism. Vitamin D was first discovered at the beginning of the 20th century as a missing nutrient in children with severe bone demineralization, a disease called rickets.

In humans, the most important related compounds of vitamin D are vitamin D<sub>2</sub> (ergocalciferol) and vitamin D<sub>3</sub> (cholecalciferol).<sup>[1]</sup> Vitamin D<sub>2</sub> is synthesized by plants (mainly mushrooms and yeast), whereas vitamin D<sub>3</sub> is synthesized in skin when it is exposed to ultraviolet B rays from sunlight or from artificial food source such as fatty fish, eggs, beef liver, and mushrooms. So, it is also called "sunshine vitamin."<sup>[2]</sup>

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A diet deficient in vitamin D causes osteomalacia in adults and rickets in children. In the developed world, this is a rare disease. But, vitamin D deficiency has already emerged as a worldwide issue in the elderly people and found common in children and adults. Vitamin D has been postulated to have a role not only in calcium/phosphate homeostasis but in the prevention of cancer, autoimmune conditions, and cardiovascular disease.<sup>[3]</sup> Deficiency of vitamin D results in impaired bone mineralization and bone damage, which leads to bone-softening diseases.<sup>[4]</sup>

Individuals obtain vitamin D either through consuming vitamin D-rich foods (oily fish and dairy products) or through the skin's exposure to ultraviolet B radiation from sunlight. This vitamin D, once it enters the body, is extracted by the liver and converted to calcidiol, which is also known as 25-hydroxy vitamin D [25(OH)D]. This 25(OH)D circulates in the blood stream and is the specific vitamin D metabolite, measurement of which in serum helps in determining a person's vitamin D status.<sup>[5]</sup> Kidneys convert some amount of calcidiol to calcitriol, which is the biologically active form of vitamin D and also known as 1,25-dihydroxy vitamin D [1,25(OH)<sub>2</sub>D]. Calcitriol, circulating in the blood as a hormone, regulates the concentrations of calcium and phosphate in the bloodstream and promotes the healthy growth and remodeling of bone.

The best indicator of total body vitamin D storage is 25(OH)D because its half-life (2–3 weeks) is far greater than that of 1,25(OH)<sub>2</sub>D (8–12 h).<sup>[6]</sup> The circulating concentration of 25(OH)D is in nanogram per milliliter, almost 1000-fold higher than the concentrations of 1,25(OH)<sub>2</sub>D. The 25(OH)D also stimulates the vitamin D receptors.

Apart from its bone health-specific use, vitamin D is also used in patients with cardiovascular disease,<sup>[7,8]</sup> multiple sclerosis,<sup>[9]</sup> pregnancy to prevent gestational diabetes, preeclampsia, and small infants,<sup>[10]</sup> tuberculosis,<sup>[11]</sup> HIV,<sup>[12]</sup> and deadly form of breast cancer.<sup>[13]</sup> Reduced levels of vitamin D in blood are related to increased mortality,<sup>[14]</sup> and providing vitamin D<sub>3</sub> as supplementary to elderly women in institutional care has been found to decrease the risk of death.

An excess of vitamin D causes abnormally high blood concentrations of calcium (hypercalcemia), which can cause overcalcification of the bones, soft tissues, heart, and kidneys. It can also damage the kidney and produce kidney stones. In addition, hypertension can result.<sup>[15]</sup> The symptoms of hypervitaminosis D appear several months after administration of overdoses of vitamin D, which are dehydration, vomiting, decreased appetite, irritability, constipation, fatigue, and muscle weakness.

If the sunlight exposure is not adequate, then the commonly recommended daily intake of vitamin D will not be suffice.<sup>[16]</sup> According to the United States Institute of Medicine,<sup>[17]</sup> the recommended daily dietary allowances of vitamin D are : up to 1 year, 400 IU; from 1 year to 70 years, 600 IU; and after 70 years, 800 IU (conversion: 1  $\mu$ g = 40 IU and 0.025  $\mu$ g = 1 IU).

## Materials and Methods

This is a cross-sectional study, carried out among the higher socioeconomic populations of various age and sex in Ahmedabad City, Gujarat, India, during April 1, 2013, to September 30, 2014. In this study, all the 444 subjects who came for the estimation of 25(OH)D level of both the sexes have been included. Informed consent was obtained from all the subjects. The exclusion criteria include: (i) pregnant and lactating women and (ii) those who were taking vitamin supplements. Blood samples were collected from all the 444 subjects after overnight fasting and under aseptic precaution into plain vacutainers and labeled properly. After that, serum was separated and labeled properly. Then, the serum 25(OH)D level estimation was done by the electrochemiluminescence immunoassay (ECLIA) method using an automated clinical chemistry analyzer (Elecys 2010; Roche Diagnostics).

Reference range for the serum 25(OH)D level recommended by Mayo Medical Laboratory is 29–80 ng/mL.<sup>[18]</sup> Mayo Medical Laboratories<sup>[18]</sup> has categorized serum vitamin D level < 10 ng/mL as severe deficiency, between 10 and 28 ng/mL as mild to moderate deficiency, between 29 and 80 ng/mL as optimal levels, and >80 ng/mL as toxicity possible. But, in this study, we considered the serum 25(OH)D level greater than 30 ng/dL as adequate, between 21 and 28 ng/dL as mildly deficient, between 10 and 20 ng/dL as moderately deficient, and between 0 and 9 ng/dL as severely deficient.

## Results

This cross-sectional study was carried out for period of 18 months, and a total of 444 patients were selected for serum 25(OH)D level estimation. Of the total 444, there were 144 (32.4%) male and 300 (67.6%) female patients. Among these 444 patients, 30 (6.7%) were having adequate level, 31 (7.0%) mild deficiency, 177 (39.9%) moderate deficiency, and 206 (46.4%) severe deficiency of vitamin D.

Of the total 444 subjects, 41 (9.2%) were between 0 and 20 years, 112 (25.2%) 21 and 40 years, 158 (35.6%) 41 and 60 years, and 133 (30.0%) older than 60 years. Of the total 444 subjects, 30 (6.7%) were having adequate level; 31 (7.0%) were mildly deficient, 177 (39.9%) moderately deficient, and 206(46.4%) severely deficient.

For mildly deficient cases, of the total 31 cases, 20 were female and 11 were male subjects; 11 (35.4%) subjects were aged between 0 and 20 years, 6 (19.4%) 21 and 40, 8 (25.8%) 41 and 60 years, and 6 (19.4%) older than 60 years.

For moderately deficient cases, of the total 177 cases, 123 were female and 54 were male subjects; 16 (9.1%) subjects were aged between 0 and 20 years, 50 (28.2%) 21 and 40 years, 70 (39.5%) 41 and 60 years, and 41(23.2%) older than 60 years.

For severely deficient cases, of the total 206 cases, 137 were female and 69 were male subjects; 6 (2.9%) subjects were aged between 0 and 20 years, 51 (24.7%) 21 and 40 years, 74 (36.4%) 41 and 60 years, and 75 (36.4%) older than 60 years.

## Discussion

In this study, 32.4% were male and 67.6% were female patients; 6.7% were having adequate level of vitamin D, 7.0% mild deficiency, 39.9% moderate deficiency, and 46.4% severe deficiency of vitamin D.

For mildly deficient cases, maximum subjects (35.4%) were aged between 0 and 20 years. For moderately deficient cases, maximum subjects (39.5%) were aged between 41 and 60 years. For severely deficient cases, maximum subjects (36.4%) were older than 60 years.

In general, majority of the deficient subjects (35.6%) were aged between 41 and 60 years, which is followed by older than 60 years (0%). So, two-third of the subjects was aged older than 40 years. The majority of the deficient subjects (46.4%) were severely deficient, which is followed by moderately deficient subjects (39.9%). Hence, more than 85% of the subjects were moderate to severely deficient. Severity of deficiency also increases with the age.

In the study by Arya et al.<sup>[19]</sup> in 2004, of the total 92 subjects, 78.3% were having vitamin D deficiency. In the study by Harinarayan et al.<sup>[20]</sup> in 2004, of the total 316 subjects, 69.3% were having vitamin D deficiency. In the study by Vupputuri et al.<sup>[21]</sup> in 2006, of the total 105 subjects, 94.3% were having vitamin D deficiency. In the study by Zargar et al.<sup>[22]</sup> in 2007, of the total 92 subjects, 83% were having vitamin D deficiency. In the study by Agarwal et al.<sup>[23]</sup> in 2013, of the total 200 subjects, 58% were having vitamin D deficiency. In this study, of the total 444 subjects, 93.3% were having vitamin D deficiency, which is closely similar to the study by Vupputuri et al. and higher than the studies by Zargar et al. and Arya et al. In one of the study of 18 cities spread all over India done by Beloyartseva et al.<sup>[24]</sup> of the total 2,119 subjects, 79% were found deficient in vitamin D level.

## Conclusion

Vitamin D plays an important role in a wide range of physiologic functions. Serum vitamin D level estimation must be done in health-care management of skeletal disorders and nutritional review status of the population.

Serum 25(OH)D is the best measure of vitamin D exposure indicating both the effects of diet and sunlight. Persons with sun-avoidance behaviors were at higher risk for developing vitamin D deficiency. Vegetarian population has higher risk of vitamin D deficiency. Severity of vitamin D deficiency also increases with the age.

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