

Revisiting Vitamin D ‘Normal Levels’: Is Deficiency Overdiagnosed?

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ABSTRACT

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Vitamin D deficiency is widely diagnosed based on serum 25-hydroxyvitamin D levels, yet the thresholds defining deficiency and sufficiency remain inconsistent across guidelines. While the 2011 Endocrine Society guidelines defined vitamin D sufficiency as serum levels of ≥ 30 ng/mL, recent evidence — and the 2024 update — have moved away from such fixed numerical cut-offs. In recent years, there has also been growing criticism of certain experts who continue to advocate higher target levels despite limited evidence of clinical benefit. This change reflects growing recognition that vitamin D levels vary widely among individuals, and that modestly lower levels are not consistently associated with adverse clinical outcomes. Studies from India and elsewhere demonstrate that populations with levels far below 30 ng/mL often remain healthy, suggesting that applying previously established Western thresholds may label large numbers of individuals as “deficient” without clinical justification. Overdiagnosis leads to unnecessary supplementation and puts people at risk for toxicity. Establishing region-specific reference ranges that consider local sunlight exposure, diet, and ethnicity is essential. A one-size-fits-all approach risks medicalising normal biological variation rather than addressing true deficiency.

Keywords: Vitamin D deficiency, Sunlight exposure, Dietary fortification, Bone health, Calcium homeostasis

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INTRODUCTION

Vitamin D deficiency is a commonly used term signifying an abnormally low level of 25-hydroxyvitamin D in the serum. Deficiency may arise from inadequate sunlight exposure, insufficient dietary intake, impaired intestinal absorption, defective metabolic activation, or increased physiological requirements and losses. In clinical practice, a major contributor to deficiency is limited sun exposure, sometimes compounded by inadequate dietary intake.

Defining Vitamin D Deficiency and Sufficiency

Because vitamin D has multiple biological roles, the presence of a deficiency implies a need for supplementation. Although the body is capable of synthesizing vitamin D through skin exposure to sunlight, when deficiency occurs, vitamin D is administered in the form of oral or parenteral supplements and also through dietary fortification. There is no doubt that vitamin D is necessary for optimal bone health and other physiological functions. However, there is lack of clarity

about the exact level below which supplementation is required.

Expert bodies define vitamin D sufficiency as the serum 25(OH)D level adequate to maintain normal calcium metabolism and bone health, whereas deficiency is the level below which calcium absorption is impaired, parathyroid hormone rises, or bone outcomes are adversely affected.

When reporting vitamin D levels, different laboratories report different thresholds for sufficiency, insufficiency, and deficiency. This leads to confusion among doctors as well as patients. To complicate matters further, various scientific societies and professional organisations advocate their own cut-offs.

Variability in Reference Levels

For instance, the definition of vitamin D deficiency remains inconsistent across authorities, with cut-offs ranging from <10 ng/mL in the United Kingdom Scientific Advisory Committee on Nutrition (SACN)³,

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<12 ng/mL in the Institute of Medicine/National Academies of Sciences, Engineering, and Medicine (IOM/NASEM)¹ and the Indian Academy of Pediatrics, and up to <20 ng/mL in the 2011 guidelines of the Endocrine Society² and the European Food Safety Authority (EFSA).⁴ This lack of consensus creates confusion in both research and clinical practice.

The threshold for vitamin D sufficiency is equally variable, with ≥ 30 ng/mL recommended by the 2011 guidelines of the Endocrine Society,² ≥ 20 ng/mL considered adequate by the IOM/NASEM¹ and the EFSA,⁴ and only ≥ 10 ng/mL set as the minimum target by the UK SACN.³ This again highlights the absence of uniformity in defining what constitutes adequate vitamin D status.

Recent publications^{1,2} acknowledge the ambiguity in threshold levels. Accordingly, the Endocrine Society's 2024 guidelines no longer endorse specific 25-hydroxyvitamin D (25[OH]D) levels to define sufficiency, insufficiency, or deficiency. This reflects a shift away from fixed numerical cutoffs toward a more individualized approach to vitamin D assessment and supplementation. In 2011, the Endocrine Society had recommended a target 25(OH)D level of 30 ng/mL, with a preferred range of 40–60 ng/mL for optimal health. The 2024 guideline no longer endorses the previous target 25(OH)D level of 30 ng/mL, and acknowledges that vitamin D requirements and responses vary among individuals, making fixed thresholds inappropriate for universal application. Accordingly, the Society now advises against routine 25(OH)D testing in healthy individuals without risk factors, and recommends tailoring supplementation to individual needs—a notable change from prior recommendations.

Factors Influencing Vitamin D Levels

What makes vitamin D unique compared to other vitamins is the ability of the human body to manufacture it through skin exposure to sunlight. Consequently, serum vitamin D levels fluctuate with the seasons. In Western nations, levels are higher in summer and lower in winter when sun exposure is reduced.⁸ In tropical regions closer to the equator, seasonal variation is minimal. People who habitually stay indoors and are not exposed to sunlight generally have lower vitamin D levels. Individuals with lighter skin synthesize vitamin D more efficiently because lower melanin content allows greater ultraviolet B penetration, resulting in higher circulating 25-hydroxyvitamin D levels. Dietary sources also contribute: those who consume fatty fish such as mackerel, sardines, and fish liver tend to have higher

vitamin D levels. Being fat-soluble, vitamin D deficiency can also occur in conditions associated with fat malabsorption. However, since vitamin D is produced in the skin, this can offset some of the deficiency.

Challenges in Defining Optimal Levels

Determining the optimal vitamin D level below which supplementation is warranted is not straightforward. Laboratory reference ranges are derived from a healthy population and typically defined as the central 95% of values in a Gaussian distribution (mean $\pm$ 2 SD). By definition, 5% of healthy individuals fall outside this range without necessarily having disease.

Clinical thresholds are based on levels at which complication risk increases. For potassium, this is clear-cut: serum levels between 3.5 and 5.0 mmol/L are considered normal, and deviations are classified as hypo- or hyperkalemia because they are associated with muscular and cardiac complications. Vitamin D presents greater complexity: given its multiple physiological roles and the absence of a reliable marker of deficiency, it is difficult to identify a single cutoff below which clinically meaningful adverse outcomes occur.⁹

The arbitrariness of such thresholds can be illustrated by analogy: if “normal adult height” were defined as 6 feet, most people in India would be labelled short despite being healthy within their genetic and environmental context. Likewise, defining an inappropriately high normal level for vitamin D would label many healthy individuals as “deficient”, and lead to unnecessary treatment.

Further complicating matters is the wide variability in sunlight exposure worldwide. Latitude strongly influences risk: populations near the equator, with year-round sun exposure, are less likely to be deficient, whereas those at higher latitudes are more vulnerable.⁸ In many industrialised countries, food fortification (e.g., orange juice, flour, bread) is used to mitigate this risk.

Population-Specific Considerations

Among its multiple roles, bone health is the most extensively studied, and several attempts have been made to define normal vitamin D levels using bone-related outcomes. Low vitamin D reduces intestinal calcium absorption, leading to a drop in serum calcium and a compensatory rise in parathyroid hormone (PTH). Therefore, the vitamin D level below which hypocalcemia develops or parathyroid hormone begins to rise has often been used as a cut-off for deficiency.¹⁰ Below this threshold, supplementation helps preserve bone health and prevent complications.

Unfortunately, no single normal level is consistent across populations worldwide.¹¹ In a study among healthy aircrew and aspirants for the Air Force Academy from across India, aged 20–50 years, almost all participants had vitamin D levels below 30 ng/mL.⁶ The mean level was 14.05 ng/mL. By definition, a healthy population cannot all have abnormal values, which indicates that 30 ng/mL is not an appropriate sufficiency threshold in this group of healthy young adults. In this study, hypocalcemia was seen only when vitamin D levels were below 13.5 ng/mL.⁶ The authors suggested that insufficiency begins at 13.5 ng/mL and deficiency at 7 ng/mL.¹¹

A study from the UK found that most children with elevated parathyroid hormone and abnormal bone metabolism had vitamin D levels below 13.6 ng/mL.⁷ A study from northern India on healthy schoolchildren reported that only when vitamin D levels fell below 5 ng/mL did parathyroid hormone values rise to or exceed the upper limit of normal.⁵ These studies suggest that the true normal vitamin D level and deficiency threshold in healthy Indian populations are likely lower than current thresholds derived from Western populations. Revising these definitions would not only reduce over-diagnosis of deficiency but also minimize unnecessary supplementation

Risks of Indiscriminate Supplementation

Unlike most vitamins, which must be obtained from the diet, vitamin D is a hormone that can be synthesized endogenously in adequate amounts. Indiscriminate supplementation carries risks and is not supported by robust evidence. Chronic intake of excessive doses can lead to hypervitaminosis D and hypercalcemia, which may cause neurocognitive symptoms, falls, and even cardiac arrhythmias. Although uncommon, such cases occur, particularly when supplements are self-administered without medical oversight. The widespread availability of over-the-counter preparations and misinformation on social media increase this risk. For example, a recommendation of 60,000 IU once weekly may be misinterpreted as a daily dose, leading to prolonged toxic intake. Hypercalcemia often remains asymptomatic until complications develop, which in some cases may be fatal.²

CONCLUSION

Establishing clear, region-specific thresholds for vitamin D deficiency is essential. These thresholds must account for local geography, sunlight exposure, dietary patterns, and the regional burden of bone disease at-

tributable to deficiency. They should also be tailored to specific subgroups, such as age, sex, pregnancy status, and comorbidities, rather than adopting a one-size-fits-all approach. Such context-specific thresholds will ensure that supplementation strategies are both evidence-based and clinically relevant.

END NOTE

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