Vitamin D Supplementation in Pediatric Practice: An Evidence Based Practical Review

Reviewed by:

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Introduction

Vitamin D deficiency is increasingly recognized as a global public health problem affecting infants, children, and adolescents. Recent pooled data suggest that low serum 25-hydroxyvitamin D [25(OH)D] concentrations remain common across many regions of the world, including low and middle income countries.[1] In India, suboptimal vitamin D status is frequent in children, adolescents, and pregnant or lactating mothers, often coexisting with inadequate dietary calcium intake.[2]

Vitamin D and calcium are essential for normal skeletal growth, mineralization, and attainment of peak bone mass. Deficiency may lead to nutritional rickets, osteomalacia, muscle weakness, and poor bone health outcomes later in life.[2,3] Deficiency is also associated with infectious diseases including upper respiratory tract infections, especially in infants.[4,5] Vitamin D deficiency in children is multifactorial and may be related to low dietary intake, limited sunlight exposure, darker skin pigmentation, maternal deficiency, prematurity, malabsorption, chronic liver or kidney disease, and the use of certain medications.[2,3,6]

Routine screening for vitamin D deficiency is not recommended in healthy children, but targeted testing may be considered in high risk groups.[2,3] Prevention is centered on age appropriate supplementation, maintenance of adequate calcium intake, and identification of vulnerable populations.[2,3]

Global Burden/Prevalence of Deficiency

Vitamin D deficiency is a widespread global health issue, affecting all ages and contributing to conditions like osteomalacia, along with higher risks of infections and metabolic disorders. A meta analysis of 308 studies across 81 countries shows that nearly 50% of people have low vitamin D levels (<50 nmol/L), with a greater burden in lower middle income countries. Despite some progress, deficiency remains common, highlighting the need for supplementation, food fortification, and stronger public awareness.[4]

Physiology and Role of Vitamin D in Early Life

Synthesis and Metabolism

Vitamin D3 (Cholecalciferol) is synthesized in the skin from 7-dehydrocholesterol following exposure to ultraviolet B radiation, whereas vitamin D2 (Ergocalciferol) is derived from plant sources. Vitamin D undergoes 25-hydroxylation in the liver to form 25(OH)D, the principal circulating form used to assess vitamin D status. It is subsequently converted in the kidney to the biologically active metabolite 1,25-dihydroxy-vitamin D [1,25(OH)2D].[7]

The biological effects of vitamin D are mediated through the Vitamin D Receptor (VDR), which regulates gene transcription in a tissue specific manner. Through these pathways, vitamin D plays a central role in calcium and phosphate homeostasis and skeletal mineralization.[7]

Functions in Growth and Development

Vitamin D is essential for intestinal calcium absorption, maintenance of calcium phosphate balance, and normal bone mineralization. Deficiency impairs these processes and may result in nutritional rickets in children and osteomalacia

in older individuals.[3,7] In addition to skeletal actions, vitamin D has recognized effects on muscle function and immune regulation, although evidence for many extra skeletal clinical benefits remains less consistent than for bone health.[1,3]

Factors Affecting Vitamin D Status in Infants and Children

Vitamin D status in infancy and childhood is influenced by several interacting factors. Sunlight exposure is a major determinant of endogenous vitamin D production; however, many infants and young children have limited direct sun exposure because of indoor lifestyles, cultural practices, and sun protective behaviors.[6] Skin pigmentation is also important, as children with darker skin require greater ultraviolet exposure to generate similar amounts of cutaneous vitamin D.[6]

Maternal vitamin D status strongly influences neonatal stores, because fetal vitamin D supply depends largely on placental transfer of maternal 25(OH)D.[6] Infant feeding practices also contribute: exclusive breastfeeding without vitamin D supplementation increases the risk of deficiency because breast milk generally contains insufficient vitamin D to meet infant requirements.[6,8] Additional influences include prematurity, ethnicity, genetic polymorphisms, socioeconomic status, diet, and adherence to supplementation practices.[6]

Vitamin D Deficiency in Infants and Children

Prevalence

Vitamin D deficiency remains common worldwide. A large pooled analysis of population based studies from 2000 to 2022 showed that low serum 25(OH)D concentrations continue to affect a substantial proportion of the global population, with important geographic, socioeconomic, and seasonal variation.[1] These findings support continued public health attention to prevention strategies, particularly in at risk pediatric populations.

Clinical Manifestations

In children, the most important manifestation of vitamin D deficiency is nutritional rickets, characterized by defective bone mineralization and skeletal deformities.[3] Clinical features may include delayed growth, widened wrists, frontal bossing, bowing of the legs, rachitic rosary, bone pain, delayed motor milestones, and increased fracture risk.[3,5] Severe deficiency may present with hypocalcemia, which can manifest as seizures, tetany, irritability, or muscle weakness.[3,5]

Although observational studies suggest associations between low vitamin D status and respiratory infections or other non skeletal outcomes, such associations are not always consistent, and causality remains less firmly established than for skeletal disease.[1,5]

Risk Factors

Risk factors for pediatric vitamin D deficiency include exclusive breastfeeding without supplementation, maternal deficiency, prematurity, darker skin pigmentation, inadequate sunlight exposure, malabsorption disorders, chronic liver disease, chronic kidney disease, obesity, and use of medications that alter vitamin D metabolism.[2,3,5,6] Recognition of these risk factors is important for targeted prevention and selective testing.[2]

Vitamin D Requirements in Pediatric Populations

Vitamin D recommendations differ somewhat across organizations because of variation in baseline deficiency risk, diet, sun exposure, and population context.[2,3] For practical pediatric use, infants generally require 400 IU/day, whereas older children and adolescents usually require 600 IU/day to maintain adequate vitamin D status under usual circumstances.[1,2,3]

Infants (0-12 months)

All breastfed and partially breastfed infants should receive 400 IU/day of vitamin D beginning soon after birth.[2,8] Formula fed infants may not require additional supplementation if they are consistently consuming sufficient quantities of fortified formula, but supplementation should be given if intake is inadequate.[2,8]

Children and Adolescents (1-18 years)

Most children and adolescents require 600 IU/day of vitamin D for routine prevention.[1,2] In those with minimal sun exposure, darker skin, obesity, or other risk factors, individualized supplementation may be required.[1,2]

Important Clarification

Routine preventive supplementation should be clearly distinguished from the treatment of documented deficiency. Therapeutic regimens used for vitamin D deficiency or nutritional rickets are different from maintenance doses and should be prescribed under clinical supervision.[2,3]

Special Populations

Preterm and Low Birth Weight Infants

Preterm infants are at increased risk because of reduced placental accretion of vitamin D and higher postnatal skeletal demands. These infants may require individualized supplementation and closer biochemical monitoring depending on gestation, enteral tolerance, and overall clinical condition.[2,3]

Children with Chronic Illness or Malabsorption

Children with cholestatic liver disease, cystic fibrosis, chronic kidney disease, malabsorption syndromes, or prolonged anticonvulsant or glucocorticoid therapy may require higher or individualized dosing, together with biochemical follow up.[2,3]

Obesity

Children with obesity may have lower bioavailability of vitamin D because of sequestration in adipose tissue and may require higher doses than standard age based recommendations.[1,3]

Calcium Intake and Combined Deficiency

Vitamin D deficiency frequently coexists with low calcium intake, particularly in resource limited settings and in populations consuming diets low in dairy intake or high in phytates.[2,3] This interaction is clinically important, as inadequate calcium intake can worsen the skeletal consequences of vitamin D deficiency and contributes to the pathogenesis of nutritional rickets.[2,3] Therefore, assessment and correction of calcium intake should accompany vitamin D supplementation in children at risk.[2]

Implementation Challenges

Despite clear recommendations, implementation of vitamin D supplementation remains inconsistent. Barriers include limited caregiver awareness, poor adherence after infancy, restricted access to fortified foods or supplements, low outdoor activity, and variable healthcare provider practices.[1,2]

These barriers are especially relevant in settings where screening is not routinely performed and deficiency risk remains high.[2]

Strategies to improve implementation include caregiver education, incorporation of supplementation advice into routine pediatric visits, maternal counseling during pregnancy and lactation, and wider public health measures such as food fortification where feasible.[1,2,3]

Emerging Evidence and Future Perspectives

There is strong evidence supporting the role of vitamin D in prevention of deficiency states and skeletal disease, particularly nutritional rickets.[1,3] However, evidence for extra skeletal benefits, including effects on infection outcomes, asthma, immunity, or neurodevelopment, remains variable and should be interpreted cautiously.[1,5]

Future research should focus on refining risk based supplementation strategies, identifying optimal dosing in special pediatric populations, and evaluating the long term impact of supplementation policies in diverse geographic and ethnic settings.[1,3]

Conclusion

Vitamin D remains essential for normal skeletal growth and musculoskeletal health in infants, children, and adolescents. The strongest evidence supports its role in maintaining calcium homeostasis and preventing nutritional rickets.[1,2,3] Routine screening is not recommended for healthy children, but risk based supplementation and targeted evaluation remain important in vulnerable groups.[2,3]

In pediatric practice, preventive supplementation should be age appropriate, linked with adequate calcium intake, and clearly distinguished from therapeutic regimens used for deficiency treatment.[2,3] Continued public health efforts, including improved awareness, better adherence, and context specific supplementation policies, are necessary to reduce the burden of vitamin D deficiency in childhood.[1,2]

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