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Vitamin D Status In Infants And Toddlers And Its Relationship With Growth And Immunity

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Abstract. Vitamin D plays a central role in skeletal mineralization during infancy and early childhood and also acts as a pleiotropic hormone influencing immune regulation, epithelial barrier function, and inflammatory responses. In many regions, infants and toddlers are at risk of low vitamin D status because of limited dietary sources, variable sunlight exposure, darker skin pigmentation, cultural clothing practices, prematurity, maternal deficiency, and rapid growth demands. This article reviews vitamin D status in children under two years of age and explains how it relates to linear growth, bone health, and immunity. It summarizes practical definitions of vitamin D status, major risk factors in clinical practice, and recommended intakes for infants and toddlers, emphasizing supplementation as a reliable strategy when dietary intake is insufficient.
Keywords: Vitamin D; 25-hydroxyvitamin D; infants; toddlers; rickets; growth; immunity; respiratory infections.

INTRODUCTION

Infants and toddlers are in a period of exceptionally rapid growth, and their physiology is both resilient and vulnerable: resilient because developmental systems can adapt quickly, vulnerable because deficiencies during this window can have outsized consequences. Vitamin D sits at the intersection of these realities. Historically, pediatric vitamin D has been framed through the lens of rickets and bone deformities, and that remains a clinically critical perspective. At the same time, vitamin D is now recognized as a hormone-like nutrient with receptors in many tissues and immune cells, shaping innate and adaptive immune responses. This broader understanding has fueled interest in whether vitamin D status influences infection risk, wheezing illnesses, allergic disease trajectories,

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and general immune competence. For clinicians, the challenge is translating a complex evidence landscape into safe, practical decisions in routine child health visits—especially because caregivers often hear contradictory messages about sun exposure, supplements, and laboratory testing.

MATERIALS AND METHODS

Vitamin D status is most commonly assessed using serum 25-hydroxyvitamin D, abbreviated 25(OH)D, because it reflects total vitamin D input from skin synthesis and intake and has a relatively long half-life compared with the active hormone 1,25-dihydroxyvitamin D. In clinical discussions, a frequent pitfall is treating a single number as a complete diagnosis. In reality, vitamin D status should be interpreted alongside calcium and phosphate intake, growth patterns, sun exposure, and clinical signs such as delayed motor milestones, bone pain, widening wrists, or delayed closure of fontanelles in more severe deficiency. A second pitfall is assuming "normal growth" excludes deficiency; early deficiency can be biochemically present before obvious skeletal signs appear. For this reason, pediatric guidance has long emphasized prevention through adequate intake rather than waiting for clinical rickets [2]. The U.S. CDC summarizes age-based needs as 400 IU per day for infants under 12 months and 600 IU per day for children 12–24 months, aligning with general dietary reference frameworks and supporting caregivers with clear targets [1]. These numbers are not "magic," but they are practical thresholds that reduce risk in most healthy children when combined with appropriate feeding practices.

The risk factors for low vitamin D status in infants and toddlers are both biological and social. Biologically, prematurity matters because mineral accretion in the third trimester is interrupted, and preterm infants often require individualized supplementation plans based on corrected age and feeding type. Maternal deficiency is another key driver because infants begin life with stores shaped by maternal status; this is particularly relevant in populations with limited sun exposure, darker skin pigmentation, or low intake of fortified foods. Social and environmental factors can be decisive: living at higher latitudes, winter seasons, urban indoor lifestyles, heavy air pollution, or cultural clothing that reduces skin exposure can reduce cutaneous synthesis. Feeding pattern is often the most actionable factor in the clinic. Breastfed infants are at higher risk of

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inadequate vitamin D intake unless they receive a supplement, and this is why the AAP recommends routine supplementation starting soon after birth [2]. Formula-fed infants may meet needs if they consume adequate volumes of fortified formula, but intake can be variable; mixed feeding and transition periods (for example, when toddlers shift from formula to family foods) can reintroduce risk. In short, vitamin D risk in early life is common enough that universal preventive strategies are often more efficient than trying to predict deficiency perfectly—yet targeted testing remains appropriate in higher-risk clinical scenarios or when symptoms suggest deficiency.

RESULTS AND DISCUSSION

The relationship between vitamin D and growth is best understood through calcium-phosphate metabolism and skeletal mineralization. Vitamin D promotes intestinal calcium absorption and helps maintain serum calcium and phosphate levels required for bone mineralization. In deficiency, absorption drops, parathyroid hormone can rise, phosphate can fall, and the growth plate becomes disorganized, producing rickets—classically presenting with delayed gross motor development, hypotonia, skeletal deformities, and growth impairment. While severe deficiency and rickets are the "visible" end of the spectrum, subclinical insufficiency may still matter for optimizing bone mineral content during a phase when bones are rapidly lengthening and remodeling. The practical clinical implication is that vitamin D sufficiency supports the biological conditions in which linear growth can proceed without mineral limitation; it does not "cause height," but it removes a preventable barrier. For this reason, preventive recommendations focus on ensuring minimum daily intake and on addressing dietary calcium adequacy, because vitamin D and calcium work as a functional pair rather than as independent nutrients [2], [3].

Toddlers introduce additional growth-related considerations. Their growth velocity slows compared with infancy, but their diets become less predictable, and their exposure patterns change. Some toddlers drink little fortified milk, avoid fish and eggs, and spend more time indoors. At the same time, caregivers may discontinue infant vitamin drops when the child turns one, mistakenly assuming a diversified diet automatically covers vitamin D needs. The CDC's age-based intake guidance highlights that the target increases to 600 IU per day in the 12–

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24 month period, reinforcing that vitamin D needs do not disappear after infancy [1]. Clinically, this is a counseling opportunity: providers can frame vitamin D as part of routine "growth nutrition," along with iron, protein quality, and overall energy intake. In settings where malnutrition or growth faltering is prevalent, vitamin D should be considered one piece of a broader nutrition assessment rather than as an isolated supplement decision.

The immunity dimension of vitamin D is biologically plausible and clinically intriguing, but it must be handled with discipline. Vitamin D receptors are present on immune cells, and vitamin D signaling influences innate antimicrobial responses and adaptive immune modulation. This has driven extensive research into whether supplementation reduces infections, especially acute respiratory infections. A key point for clinicians is that immune outcomes are not uniform: effects may differ by baseline vitamin D status, dosing regimen, age group, and outcome definition. Recent evidence syntheses continue to evaluate the preventive potential of supplementation for acute respiratory infections, and an updated meta-analysis in a major endocrinology journal reported results consistent with modest protective effects in some contexts while also emphasizing heterogeneity across trials [5].

CONCLUSION

Vitamin D sufficiency in infancy and toddlerhood is a practical pediatric priority because it supports calcium-phosphate homeostasis, healthy skeletal mineralization, and optimal conditions for growth, while also interacting with immune regulation in ways that may influence infection risk in certain settings. Clear intake targets—400 IU/day for infants under 12 months and 600 IU/day for toddlers—provide a simple, preventive foundation that is especially important for breastfed infants and for children with limited dietary vitamin D sources. The relationship between vitamin D and immunity is biologically plausible and supported by some clinical evidence, but effects vary by baseline status and trial design, so clinicians should avoid oversimplified claims and focus on achieving adequacy rather than megadosing.

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