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VITAMIN D DEFICIENCY IN CHILDREN: EFFECTS ON BONE METABOLISM, IMMUNE FUNCTION AND OVERALL DEVELOPMENT, AND MODERN APPROACHES TO PREVENTION

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Abstract. Vitamin D is essential for calcium-phosphorus homeostasis and normal skeletal growth in childhood, while its receptors and metabolic enzymes are also expressed in immune and other tissues. This thesis summarizes current evidence on pediatric vitamin D deficiency, emphasizing bone metabolism, immune regulation, growth and neurodevelopment, diagnosis, risk stratification and prevention. Severe deficiency may cause hypocalcemia, secondary hyperparathyroidism, impaired mineralization and nutritional rickets. Observational data also link low vitamin D status with infections, autoimmune and allergic conditions, but causal relationships and the benefits of supplementation for non-skeletal outcomes remain inconsistent. Prevention should prioritize adequate nutrition, age-appropriate supplementation when indicated, safe sunlight exposure, food fortification and targeted assessment of high-risk children. (1,2,3)

Keywords: vitamin D deficiency, children, rickets, bone metabolism, immunity, growth, prevention.

Annotatsiya. D vitamini bolalik davrida kalsiy-fosfor almashinuvi va suyaklarning normal o‘sishi uchun muhim bo‘lib, uning retseptorlari hamda metabolik fermentlari immun va boshqa to‘qimalarda ham mavjud. Ushbu tezis bolalarda D vitamini yetishmovchiligining suyak metabolizmi, immun tizim, umumiy o‘sish va rivojlanishga ta’sirini, shuningdek diagnostika, xavf guruhlarini aniqlash va profilaktikaning zamonaviy yondashuvlarini yoritadi. Og‘ir yetishmovchilik gipokalsemiya, ikkilamchi giperparatireoz, mineralizatsiya buzilishi va raxitga olib kelishi mumkin. Immun va nevro-rivojlanish ta’sirlari bo‘yicha dalillar esa bir xil emas. Profilaktikada ovqatlanish, xavfsiz quyosh nuri, boyitilgan mahsulotlar va xavf guruhlarida maqsadli nazorat muhimdir. (1,2,6)

Kalit so‘zlar: D vitamini yetishmovchiligi, bolalar, raxit, suyak metabolizmi, immunitet, rivojlanish, profilaktika.

Аннотация. Витамин D необходим для кальций-фосфорного обмена и нормального роста скелета в детском возрасте; его рецепторы и метаболические ферменты также экспрессируются в иммунных и других тканях. В тезисе обобщены современные данные о дефиците витамина D у детей с акцентом на костный метаболизм, иммунную регуляцию, рост и общее развитие, диагностику, оценку групп риска и профилактику. Выраженный дефицит может приводить к гипокальциемии, вторичному гиперпаратиреозу, нарушению минерализации и алиментарному рахиту. Связь с инфекционными, аллергическими, аутоиммунными и нейроповеденческими исходами описана, однако причинность и эффект дополнительного приема витамина D остаются неоднозначными. (1,2,5,6)

Ключевые слова: дефицит витамина D, дети, рахит, костный метаболизм, иммунитет, рост, профилактика.

INTRODUCTION

Vitamin D is a fat-soluble secosteroid that is obtained from cutaneous synthesis after ultraviolet-B exposure, dietary sources and supplements. Its biologically important actions are mediated through

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the vitamin D receptor after hepatic conversion to 25-hydroxyvitamin D [25(OH)D] and subsequent activation to 1,25-dihydroxyvitamin D. In children, the classical function of vitamin D is to support intestinal calcium and phosphate absorption and thereby maintain the mineral environment required for normal growth-plate function and skeletal mineralization. Vitamin D deficiency remains a global pediatric problem because natural food sources are limited and risk is increased by exclusive breastfeeding without supplementation, dark skin pigmentation, limited sunlight exposure, malabsorption, chronic liver or kidney disease, obesity and the use of some anticonvulsant or glucocorticoid medications. (2,3,9,10)

MAIN PART

Bone metabolism is the best-established domain of vitamin D action. When vitamin D supply is inadequate, intestinal calcium absorption falls, parathyroid hormone secretion rises and bone turnover increases in an attempt to preserve serum calcium. In growing children, prolonged deficiency disrupts mineralization of osteoid and the growth plate, producing nutritional rickets. Clinical manifestations may include delayed motor milestones, bone pain, muscular weakness, widened wrists, genu varum or valgum, growth impairment and, in severe cases, hypocalcemic seizures or cardiomyopathy. Current consensus emphasizes that rickets is not explained by vitamin D status alone: inadequate calcium intake can also contribute, and diagnosis should integrate history, physical findings, biochemical markers and radiographic features when clinically indicated. (2,3,9)

Recent evidence also clarifies what vitamin D supplementation can and cannot be expected to achieve. In children and adolescents with overt deficiency or rickets, correction of deficiency is essential for restoring mineral homeostasis. However, a 2023 individual-participant meta-analysis found that routine supplementation in generally healthy children and adolescents produced little clinically important improvement in bone density, even though participants with symptomatic deficiency were not the primary population studied. This distinction is important: vitamin D should be used to prevent and correct deficiency rather than assumed to provide unlimited skeletal benefit above adequate nutritional status. (4)

The immune system represents the most intensively studied extra-skeletal target. Immune cells can express the vitamin D receptor and enzymes involved in local vitamin D metabolism. Experimental data suggest roles in epithelial barrier integrity, antimicrobial peptide expression, modulation of innate responses and regulation of T-cell function. Nevertheless, clinical evidence is more cautious. Observational studies frequently associate low 25(OH)D with respiratory infections, allergic disease and autoimmunity, but confounding by nutrition, adiposity, physical activity, season and chronic illness is difficult to exclude. The 2024 Endocrine Society guideline supports empiric vitamin D supplementation in children and adolescents for prevention of nutritional rickets and notes a possible reduction in respiratory tract infections, while also stressing that optimal vitamin D thresholds for broad disease prevention remain uncertain. (1,5,7)

The influence of vitamin D on overall growth and neurodevelopment is biologically plausible because vitamin D signaling participates in cell differentiation, neural development and muscle function. Yet pediatric outcome data are inconsistent. A systematic review of more than 31,000 children found that some studies linked low maternal or childhood vitamin D status with poorer cognitive, language or motor outcomes, whereas many others found no association. Therefore, low vitamin D should not be treated as a proven cause of developmental delay, although deficiency may

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coexist with poor nutrition, chronic disease or limited outdoor activity and should be corrected when clinically established. (6)

Assessment should be individualized. Serum 25(OH)D is the principal biomarker of vitamin D status, but universal screening of healthy children is not supported by current evidence. Testing is more appropriate when rickets, recurrent hypocalcemia, bone pain, fragility, malabsorption, chronic kidney or liver disease, severe obesity, long-term use of enzyme-inducing drugs, or other established risk conditions are present. Interpretation should consider calcium, phosphate, alkaline phosphatase and parathyroid hormone when metabolic bone disease is suspected. Importantly, cut-off values for "insufficiency" vary across professional societies, and the 2024 Endocrine Society guideline does not endorse a universal 25(OH)D target for disease prevention in otherwise healthy people. (1,2,3)

Modern prevention is multimodal. Infants and children should receive adequate vitamin D from diet, fortified foods and supplementation in accordance with age, feeding pattern, local public-health guidance and individual risk. International pediatric recommendations traditionally support routine supplementation during infancy, especially in breastfed infants, and continued attention to intake in older children and adolescents. Food fortification can reduce population-level deficiency where dietary sources are limited. Safe outdoor activity supports cutaneous synthesis, but intentional excessive ultraviolet exposure should not be recommended because vitamin D prevention must be balanced against skin-damage risk. In high-risk children, clinicians should address the underlying cause, including malabsorption, medication effects or chronic organ disease. (2,3,8,9)

An important principle is to avoid both undertreatment and indiscriminate high-dose supplementation. Vitamin D is a fat-soluble vitamin; excessive dosing may cause hypercalcemia, hypercalciuria, nephrocalcinosis and other complications. Prevention programs should therefore use evidence-based daily or scheduled regimens rather than unsupervised megadoses. Recent meta-analyses of respiratory infection prevention suggest that any benefit is modest and regimen-dependent, reinforcing the concept that vitamin D is primarily a nutritional and skeletal-health intervention, not a universal immune therapy. (1,7)

CONCLUSION

Vitamin D deficiency in childhood is clinically important because of its established effects on calcium-phosphate metabolism, skeletal mineralization and the risk of nutritional rickets. Vitamin D also interacts with immune pathways and may influence broader health outcomes, but current evidence for preventing infections, allergic or autoimmune disease, and developmental impairment is heterogeneous and should not be overstated. The most rational strategy is early identification of children with clinical or epidemiological risk, adequate nutritional intake, age-appropriate supplementation according to accepted guidance, food fortification where appropriate, safe outdoor activity and targeted laboratory assessment rather than indiscriminate population screening. Such an approach supports healthy skeletal development while avoiding unnecessary testing and excessive supplementation. (1,2,3)

REFERENCES:

1. Demay M.B., Pittas A.G., Bikle D.D., et al. Vitamin D for the Prevention of Disease: An Endocrine Society Clinical Practice Guideline. Journal of Clinical Endocrinology & Metabolism. 2024;109(8):1907-1947. doi:10.1210/clinem/dgae290.

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2. Munns C.F., Shaw N., Kiely M., et al. Global Consensus Recommendations on Prevention and Management of Nutritional Rickets. Journal of Clinical Endocrinology & Metabolism. 2016;101(2):394-415. doi:10.1210/jc.2015-2175.
3. Corsello A., Spolidoro G.C.I., Milani G.P., Agostoni C. Vitamin D in pediatric age: Current evidence, recommendations, and misunderstandings. Frontiers in Medicine. 2023;10:1107855. doi:10.3389/fmed.2023.1107855.
4. Wu F., El-Hajj Fuleihan G., Cai G., et al. Vitamin D supplementation for improving bone density in vitamin D-deficient children and adolescents: systematic review and individual participant data meta-analysis of randomized controlled trials. American Journal of Clinical Nutrition. 2023;118(3):498-506. doi:10.1016/j.ajcnut.2023.05.028.
5. Daryabor G., Gholijani N., Rezaei Kahmini F. A review of the critical role of vitamin D axis on the immune system. Experimental and Molecular Pathology. 2023;132-133:104866. doi:10.1016/j.yexmp.2023.104866.
6. Mutua A.M., Mogire R.M., Elliott A.M., et al. Effects of vitamin D deficiency on neurobehavioural outcomes in children: a systematic review. Wellcome Open Research. 2020;5:28. doi:10.12688/wellcomeopenres.15730.2.
7. Wang C.H., Porta L., Yang T.K., et al. Optimal methods of vitamin D supplementation to prevent acute respiratory infections: a systematic review, dose-response and pairwise meta-analysis of randomized controlled trials. Nutrition Journal. 2024;23:92. doi:10.1186/s12937-024-00990-w.
8. Saggese G., Vierucci F., Prodam F., et al. Vitamin D in pediatric age: consensus of the Italian Pediatric Society and the Italian Society of Preventive and Social Pediatrics, jointly with the Italian Federation of Pediatricians. Italian Journal of Pediatrics. 2018;44:51. doi:10.1186/s13052-018-0488-7.
9. Misra M., Pacaud D., Petryk A., Collett-Solberg P.F., Kappy M. Vitamin D deficiency in children and its management: review of current knowledge and recommendations. Pediatrics. 2008;122(2):398-417. doi:10.1542/peds.2007-1894.
10. Antonucci R., Locci C., Clemente M.G., Chicconi E., Antonucci L. Vitamin D deficiency in childhood: old lessons and current challenges. Journal of Pediatric Endocrinology and Metabolism. 2018;31(3):247-260. doi:10.1515/jpem-2017-0391.

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