perplexity

Nutrients Associated with Short Stature in Children

Short stature in children can result from various causes, including nutritional deficiencies. Research has identified several key nutrients that, when deficient, may contribute to impaired growth and development in children. This report examines the nutrients most commonly found to be deficient in children with short stature and explores their roles in the growth process.

Essential Minerals for Growth

Zinc

Zinc deficiency has been strongly linked to growth faltering in children. There is compelling evidence that even mild to moderate zinc deficiency can significantly affect growth[1]. Studies show that zinc supplementation may have a positive effect on catch-up growth in children with failure to thrive (FTT), particularly those who are underweight or in early stages of growth retardation[2]. Zinc plays a critical role in cell division, protein synthesis, and the function of growth hormone, making it essential for normal linear growth[3].

Research indicates that zinc supplementation may have a greater impact on growth in stunted compared to non-stunted children[3]. One study found that daily zinc supplementation for 6 months significantly increased height-for-age Z-scores in children with mild to moderate stunting[2]. Zinc deficiency can lead to loss of appetite, growth retardation, and impaired immune function[4].

Iron

Iron deficiency anemia (IDA) shows a significant association with stunted growth in children. A meta-analysis revealed that children with IDA have 2.27 times higher risk of being stunted compared to children without IDA[5]. The study demonstrated that 24.5% of children with IDA were stunted[5].

Iron contributes to tissue growth through its role in DNA synthesis, and iron-deficient states can hinder tissue growth, leading to growth disruption[5]. Additionally, iron deficiency makes children more susceptible to infections due to compromised immune responses, which can further impair growth[5]. In a comparative study, short stature children had significantly lower iron intake (5.6 ± 0.4 mg) compared to children of normal height (7.1 ± 0.3 mg)[6].

Calcium

Calcium is essential for bone development and growth in children. Research shows that children with short stature had significantly lower calcium intake (364.7 ± 25.7 mg) compared to children of normal height (453.5 ± 20.4 mg)[6]. Calcium homeostasis is crucial for bone health and growth, and inadequate calcium intake, often due to insufficient milk consumption after weaning, may contribute to stunting in children[7].

While calcium deficiency in animals causes reduced bone mineralization and strength without affecting linear growth, vitamin D and calcium administration together restore normal bone growth in children with nutritional rickets[7]. In adolescent boys, calcium supplementation over 13 months was associated with increased height[7].

Critical Vitamins for Linear Growth

Vitamin D

Vitamin D deficiency has been clearly linked to impaired height growth in children. A study from the Japan Environment and Children's Study found that definitive vitamin D deficiency (<10 ng/mL) impaired height growth by 0.6 cm per year even in children who didn't have short stature[8]. This research demonstrated that the effect of vitamin D deficiency on growth was not limited to children with clinically defined short stature[8].

Vitamin D works synergistically with calcium in bone development, and its deficiency can lead to rickets and subsequent growth impairment[9]. Children with vitamin D deficiency were found to have reduced outdoor activity, especially during winter months, which further contributed to their deficiency[8].

Vitamin A

Vitamin A deficiency has been associated with higher odds of stunting in children. Research indicates that this association is independent of individual, household, and community-level variables[10]. While some trials have reported little or no benefit of vitamin A supplementation on linear growth, a recent meta-analysis suggested that vitamin A supplementation may have a positive effect on linear growth in children older than 2 years[7].

Vitamin B12

Vitamin B12 deficiency is recognized as a rare but treatable cause of failure to thrive and delayed development in infants[11]. It is essential for the development of the central nervous system, and deficiency during early childhood can lead to neurodevelopmental delay and regression[11].

Long-term deficiency of vitamin B12 may cause demyelination of the brain, though the exact mechanism in nervous system metabolism is not fully understood[11]. Neurological damage is thought to occur in the first 6 months of life when myelination of the brain is very active. Vitamin B12 deficiency may lead to impaired synthesis of ethanolamine, phospholipids, and sphingomyelin, resulting in altered myelin integrity[11].

Vitamin K2

Emerging evidence suggests that vitamin K2 (VK2) deficiency may be associated with an increased risk of short stature in children[12]. A cross-sectional study found that children with short stature exhibited lower VK2 levels compared to children of average height, and VK2 deficiency was identified as an independent risk factor for short stature (OR = 1.535)[12].

Macronutrients and Growth

Protein

Protein plays a permissive role in growth by fulfilling the metabolic demand for amino acids required for tissue growth and by increasing levels of hormones such as insulin and IGF-I, which stimulate endochondral ossification[7]. In humans, protein deficiency leads to growth failure[7].

Research has shown that short stature children had significantly lower protein intake (32.9 ± 1.6 g) compared to children of normal height (39.6 ± 1.3 g)[6]. The source of protein also appears to be important, as one study found that short stature children obtained less protein from plant food sources, particularly legumes[6].

Fat

Fat intake is also important for normal growth and development. Children with short stature were found to have significantly lower fat intake (22.4 ± 1.5 g) compared to children of normal height (28.3 ± 1.2 g)[6]. However, the specific mechanism by which fat deficiency affects growth is not as clearly delineated in the research as it is for other nutrients.

Nutritional Interactions and Growth

The relationship between nutrition and growth is complex, with multiple nutrients often working synergistically. For example, calcium and vitamin D function together to promote bone health and growth[7] [9]. Similarly, zinc supplementation alone shows a greater effect on linear growth than when supplemented in combination with iron, possibly because of interference with zinc absorption or bioavailability[3].

It's worth noting that important contributory factors to growth failure include increased energy needs, increased energy loss, malabsorption, decreased energy intake, anorexia, pain, vomiting, intestinal obstruction, and inflammatory cytokines[13]. These factors can affect the availability and utilization of nutrients necessary for growth.

Conclusion

Nutritional deficiencies play a significant role in the development of short stature in children. The evidence strongly suggests that deficiencies in zinc, iron, calcium, vitamins D, A, B12, K2, protein, and fat may contribute to impaired linear growth. Understanding these nutritional factors is crucial for the prevention and treatment of growth disorders.

Early identification and correction of these nutritional deficiencies can help prevent growth faltering and its long-term consequences. Targeted nutritional interventions based on individual

assessment may improve growth outcomes in children with or at risk for short stature. Healthcare providers should consider comprehensive nutritional evaluation as part of the assessment of children presenting with growth concerns.

⁂

1. https://pubmed.ncbi.nlm.nih.gov/14672304/
2. https://pmc.ncbi.nlm.nih.gov/articles/PMC5712499/
3. https://www.who.int/tools/elena/bbc/zinc-stunting
4. https://kidsnewtocanada.ca/conditions/zinc
5. https://pmc.ncbi.nlm.nih.gov/articles/PMC11505671/
6. https://pmc.ncbi.nlm.nih.gov/articles/PMC3572808/
7. https://pmc.ncbi.nlm.nih.gov/articles/PMC9100533/
8. https://pmc.ncbi.nlm.nih.gov/articles/PMC9415323/
9. https://www.rileychildrens.org/health-info/growth-disorders-short-stature
10. https://pmc.ncbi.nlm.nih.gov/articles/PMC7259702/
11. https://pmc.ncbi.nlm.nih.gov/articles/PMC8140678/
12. https://pubmed.ncbi.nlm.nih.gov/39740283/
13. https://pubmed.ncbi.nlm.nih.gov/25378356/