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Current strategies in pediatric supplementation: from correcting deficiencies to functional bioactives.

Current strategies in Pediatric supplementation: from correction of deficiencies to functional bioactives

Ana Laura Caixeta Lima - Estácio University Center of Ribeirão Preto

Email: analauracaixeta@hotmail.com

Laura Silva Ferreira - Estácio University Center of Ribeirão Preto

Email: sferreira_laura@hotmail.com

Bárbara Loyolla Candido - Estácio University Center of Ribeirão Preto

Email: barbara-loyolla@hotmail.com

Summary

Objective: To synthesize recent evidence on pediatric supplementation, highlighting the evolution from the traditional approach of correcting deficiencies to strategies focused on optimizing body composition, linear growth, and immune modulation. Methods: A narrative review was conducted based on publications from 2020 to 2025, including randomized clinical trials, systematic reviews, and relevant clinical guidelines. The analysis focused on micronutrient interventions, the efficacy of oral nutritional supplements (ONS) on body composition and growth, and the emerging role of bioactive compounds. Results: High rates of iron, vitamin D, zinc, and iodine deficiency persist, with consequences for neurocognitive and physical development. Recent clinical trials demonstrate that complete ONS, when associated with dietary counseling, promote greater linear recovery and lean mass accretion compared to counseling alone, without a disproportionate increase in adiposity.

Bioactive ingredients, such as lactoferrin, TGF-beta, nucleotides, and prebiotics, show potential for modulating the immune and gastrointestinal systems, although the evidence remains heterogeneous. There is a growing and unsupervised use of supplements by children and adolescents, motivated primarily by aesthetic interests and perceptions of improved immunity. Conclusion: Contemporary pediatric supplementation should prioritize personalized, evidence-based interventions focused on growth quality, with caution regarding the indiscriminate use of supplements in healthy populations. The use of neurotransmitters and bioactives emerges as a promising tool in at-risk groups, but requires careful prescription and professional monitoring.

Keywords: Oral Nutritional Supplements; Micronutrients; Child Growth; Body Composition; Bioactives.

Abstract

Objective: To synthesize recent evidence on pediatric supplementation, highlighting the evolution from traditional deficiency-correction approaches to strategies aimed at optimizing body composition, linear growth, and immunological modulation. Methods: A narrative review was conducted based on publications from 2020 to 2025, including randomized clinical trials, systematic reviews, and relevant clinical guidelines. The analysis focused on micronutrient interventions, the efficacy of oral nutritional supplements (ONS) on growth and body composition, and the emerging role of bioactive compounds. Results: High rates of iron, vitamin D, zinc, and iodine deficiency persist globally, with consequences for neurocognitive and physical development. Recent trials demonstrate that complete ONS, when combined with dietary counseling, promotes greater linear catch-up growth and lean mass accretion compared with counseling alone, without disproportionate fat gain. Functional ingredients such as lactoferrin, TGF-ÿ, nucleotides, and prebiotics show potential immunomodulatory and gastrointestinal benefits, although the evidence remains heterogeneous. An increasing and largely unsupervised use of supplements is noted among children and adolescents, often driven by aesthetic goals or perceived immune benefits. Conclusion: Contemporary pediatrics

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supplementation should prioritize evidence-based, individualized interventions focused on the quality of growth, while addressing the rising misuse of supplements in otherwise healthy populations. ONS and functional bioactives appear promising for at-risk groups but require careful prescription and clinical oversight.

Keywords: Oral Nutritional Supplements; Micronutrients; Child Growth; Body Composition; Bioactives.

1. Introduction

Proper nutrition is a key determinant of physical development.
Cognitive and immunological development during childhood and adolescence. Micronutrients such as iron, zinc, Vitamin D and iodine are essential cofactors in critical metabolic pathways, including DNA synthesis. Cell differentiation and neural myelination (HONG, 2025).

However, even with advances in nutritional policies, deficiencies persist in some countries. of different socioeconomic levels, often associated with unbalanced diets, Selective eating behaviors or chronic conditions that increase metabolic needs. (BERGER; SHENKIN, 2024). In parallel, a substantial increase in consumption is observed Dietary supplements are often given to children and adolescents without formal indication or supervision. professional (BARRETTO; GOUVEIA; ALVES, 2024). Although these products may be valuable For specific cases of nutritional risk, its indiscriminate use raises concerns regarding... safety, dosage appropriateness, and the false perception of universal benefits.

The approach to mild to moderate malnutrition has also evolved. Recent studies indicate that treatment should not be limited to weight gain, but should also consider the "quality of life." "growth," including linear recovery *(catch-up growth),* a proportional increase in lean mass. and adequate bone mineralization (OW *et* al., 2024; OW *et* al., 2025). Clinical trials, such as the series SPROUT, demonstrate that the combination of complete ONS and dietary advice surpasses Isolated interventions in various health outcomes.

Furthermore, interest in functional ingredients has been growing. Bioactive compounds Substances present in human milk, such as lactoferrin, TGF-beta, nucleotides, and prebiotics, have been... incorporated into pediatric formulations, with potential immunomodulatory benefits and Gastrointestinal (CECCHI *et* al., 2024). This *mini-review* critically analyzes recent evidence, discussing everything from correcting classic deficiencies to the role of ONS and bioactives in promotion for healthy growth.

2. Materials and Methods

A narrative review was conducted based on a systematic search of the PubMed database. (MEDLINE), covering publications from January 2020 to February 2025. The descriptors used included: "dietary supplements", "micronutrients", "oral nutritional supplements",

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"bioactive compounds", "fortification", combined with "children", "pediatrics" and "adolescents".

Randomized clinical trials, systematic reviews, meta-analyses, and other forms of clinical trials were included. Clinical guidelines published in Portuguese or English. The selected studies addressed:

1. Efficacy of isolated micronutrient supplementation in physical development and neurocognitive;
2. Impact of complete ONS on body composition and growth;
3. Evidence regarding bioactive compounds added to pediatric supplements;
4. Epidemiological data on the prevalence of deficiencies and patterns of supplement use.

Studies using exclusively animal models, case reports, and research studies were excluded. with populations carrying inborn errors of metabolism. Because it is a narrative review, it was not A meta-analysis was conducted, and limitations inherent to the methodological heterogeneity of the studies were acknowledged. studies included.

3. Results and Discussion

Micronutrient deficiencies

Iron deficiency remains the most prevalent nutritional deficiency. Worldwide, it is associated with motor and cognitive impairments, regardless of the presence of anemia. (HONG, 2025). In adolescents, recent estimates show a prevalence of iron deficiency. greater than 30% in girls, with a relatively smaller proportion of iron deficiency anemia (HONG, 2025). Food fortification demonstrates consistent effectiveness, with reductions of up to 43% in anemia in children aged 6 to 23 months (CSÖLLE *et* al., 2022).

Vitamin D deficiency is another widespread problem, affecting more than 70% of the population. adolescents in some population studies, influenced by environmental factors, pigmentation and predominantly *indoor* lifestyle (HONG, 2025; BERGER; SHENKIN, 2024). The deficiency Zinc deficiency is associated with growth retardation and an increased risk of diarrhea; supplementation reduces this risk. duration of diarrheal episodes, especially in low-income countries (HONG, 2025; TAM *et* al., 2020).

Full ONS effects on growth

Recent randomized clinical trials indicate that complete ONS, when used Along with dietary advice, they promote superior gains in parameters. anthropometric measurements compared to counseling alone. The SPROUT study (OW *et* al., 2024) demonstrated, in the 120-day follow-up, significant improvements in weight-for-Z scores. age and height-for-age, as well as a reduction in height *-for-age difference,* suggesting acceleration of linear growth.

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In a 240-day follow-up using DXA, a greater increase in mass was also observed.
lean muscle and bone mineral density increases in supplemented children, without an increase
concomitant adiposity (OW *et* al., 2025). Although some numerical differences are
Even with small body compositions, the observed patterns reinforce the idea that ONS may favor more symmetrical body compositions.
Healthy children at nutritional risk.

Bioactive ingredients in pediatric formulations

The addition of bioactive compounds to supplements aims to bring their functional properties closer to those of existing supplements.
found in human milk (CECCHI *et* al., 2024).

- **Lactoferrin:** exhibits antimicrobial and immunomodulatory properties, in addition to participating in iron metabolism.
- **TGF-beta:** acts in promoting oral tolerance and repairing the intestinal mucosa, with potential relevance in inflammatory conditions.
- **Nucleotides:** important for rapidly proliferating tissues, they can benefit maturation.
  intestinal and immunological.
- **Prebiotics (GOS/FOS):** modulate the gut microbiota, influencing stool consistency.
  and the absorption of minerals.

The literature, however, remains heterogeneous, with variability in formulations, doses, and...
outcomes analyzed.

Unsupervised use of supplements

The consumption of dietary supplements has been growing, often without proper monitoring.
Professional. Parents report motivation related to "immunity," while teenagers seek...
aesthetic or physical performance effects, including the use of proteins and amino acids (BARRETTO;
(GOUVEIA; ALVES, 2024). Lack of guidance increases the risk of inappropriate doses and interactions.
medication and unrealistic expectations of benefits (BERGER; SHENKIN, 2024; BARRETTO;
(GOUVEIA; ALVES, 2024).

The findings of this review indicate a paradigm shift in pediatric supplementation.
which moves beyond simply correcting deficiencies to an approach focused on optimizing the
Body composition and linear growth. The concept of "quality of growth" is central.
In this process, recognizing that weight gain alone does not adequately reflect recovery.
nutritional (OW *et* al., 2024; OW *et* al., 2025).

The SPROUT study provides robust evidence that comprehensive, integrated ONS systems...
Dietary advice promotes linear growth and a healthier body composition than...
isolated advice. Although some absolute differences are modest, the standard

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Consistent improvement suggests relevant clinical impact in populations at nutritional risk (OW *et* al., 2025).

The incorporation of bioactive compounds represents an emerging frontier, but the generalization of their use is still a long way off.

While caution is still warranted regarding potential benefits, studies have shown small sample sizes and heterogeneity. The lack of formulation and the absence of standardized dosages are aspects that limit definitive conclusions. (CECCHI *et* al., 2024).

The coexistence of significant nutritional deficiencies and indiscriminate use of supplements. This highlights a worrying duality. While many groups remain vulnerable to shortages Rich in iron, vitamin D, and zinc, healthy teenagers and children often consume supplements without formal indication (HONG, 2025; BERGER; SHENKIN, 2024; BARRETTO; (GOUVEIA; ALVES, 2024). This reinforces the need for clinical practice grounded in evidence, with targeted prescription and family education for the rational use of these products.

Finally, the impact of the environmental context, including repeated infections and insecurity. Nutritional and sanitary conditions should always be considered when interpreting results on linear growth (CSÖLLE *et* al., 2022; TAM *et* al., 2020). Isolated nutritional interventions They are rarely sufficient in highly adverse environments.

Final considerations

Recent literature demonstrates that pediatric supplementation has evolved beyond mere correction. of specific deficiencies, incorporating strategies aimed at optimizing body composition and Linear growth. Complete ONSs deliver consistent benefits in at-risk populations. nutritional, especially when combined with dietary advice.

Micronutrient supplementation remains essential, especially for iron. Vitamin D and zinc, given their high prevalence and impact on child development. Bioactives Lactoferrin, TGF-beta, and prebiotics are emerging as promising adjuvants, but further research is still lacking. greater standardization and long-term studies.

Given the increase in unsupervised use of supplements, it becomes essential that Pediatricians should adopt an individualized approach, balancing precise indication, safety, and... education of families, to ensure that each child reaches their full growth potential and health.

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