REVISÃO

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Interventions for managing hidden hunger syndrome in children: a review of current evidence

Intervenções para o manejo da síndrome da fome oculta em crianças: uma revisão das evidências atuais

Running title: *Hidden hunger in children.*

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ABSTRACT

Introduction: Hidden hunger syndrome (HHS) is characterized by a silent deficiency of essential micronutrients that negatively impacts child growth, development, and well-being. The prevalence of HHS is high in vulnerable populations, and it is a condition that is difficult to diagnose without specific tests because it presents with no or minimal clinical manifestations. **Objective:** to summarize and present current evidence on therapeutic interventions in children with HHS. **Methods:** This is a narrative review of the literature conducted by including original articles that used randomized clinical trial and systematic review designs, published in scientific journals indexed in the PubMed database, between 2020 and 2024. **Results:** Five original articles met the eligibility criteria and evidenced that micronutrient supplementation (*e.g.,* iron, zinc, and vitamin A) and/or educational/behavioral strategies (*e.g.,* lecture, informational material, and counseling) improved children's nutritional status, reducing anemia, increasing serum micronutrient levels, and promoting healthy eating habits. Specifically, iron supplementation significantly improved cognitive function in infants and schoolchildren. In addition, food fortification/biofortification stood out as viable alternatives for clinically addressing HHS in the articles reviewed. **Conclusion:** Micronutrient supplementation and educational strategies are crucial in the treatment of the HHS, impacting nutritional profile and child development. However, the scarcity of important clinical outcomes, such as mortality, limits the scope of the results and further studies are needed to improve interventions and public policies aimed at reducing HHS in children.

Keywords: Hidden Hunger. Deficiency Diseases. Micronutrients. Dietary Supplements. Biofortification.

RESUMO

Introdução: A síndrome da "fome oculta" (SFO) é caracterizada pela deficiência silenciosa de micronutrientes essenciais que impactam negativamente no crescimento, desenvolvimento e bem-estar infantil. A prevalência da SFO é alta em populações vulneráveis, sendo uma condição de difícil diagnóstico sem exames específicos por cursar com nenhuma ou discreta manifestação clínica. **Objetivo:** sintetizar e apresentar as evidências atuais sobre o uso de intervenções terapêuticas em crianças com SFO. **Métodos:** Trata-se de uma revisão narrativa da literatura conduzida por meio da inclusão de artigos originais do tipo ensaio clínico randomizado e revisão sistemática, publicados em revistas científicas indexadas na base de dados PubMed, entre os anos de 2020−2024. **Resultados:** Cinco artigos originais atenderam aos critérios de eligibilidade e evidenciaram que a suplementação com micronutrientes (*e.g.,* ferro, zinco e vitamina A) e/ou estratégias educativas/comportamentais (*e.g.,* palestra, material informativo e aconselhamento) melhoraram a condição nutricional infantil, reduzindo a anemia, aumentando os níveis séricos de micronutrientes e favorecendo hábitos alimentares saudáveis. Especificamente, a suplementação com ferro melhorou significativamente a função cognitiva em crianças lactentes e escolares. Além disso, a fortificação/biofortificação alimentar destacaram-se como alternativas viáveis para se abordar clinicamente a SFO nos artigos avaliados. **Conclusão:** A suplementação com micronutrientes e as estratégias educativas desempenham papel crucial no manejo da SFO, com impacto positivo no perfil nutricional e no desenvolvimento infantil. Contudo, a escassez de desfechos clínicos importantes como mortalidade limita o alcance dos resultados obtidos, sendo necessários mais estudos para se aprimorar as intervenções e políticas públicas direcionadas à redução dos casos de SFO em crianças.

Palavras-chave: Fome Oculta. Deficiências Nutricionais. Micronutrientes. Suplementos Nutricionais. Biofortificação.

INTRODUCTION

Nutritional health plays a fundamental role in the growth, development, and overall well-being of children. An adequate and diversified diet is mandatory to ensure energy and nutritional needs throughout the various stages of childhood.[1,2] Nutrients such as proteins, carbohydrates, fatty acids, and especially vitamins and minerals are critical for optimal physical and cognitive function from the first days of life. Dietary patterns established during childhood are likely to persist into adulthood, thereby underscoring the importance of early nutritional education and guaranteed access to healthy foods. These strategies constitute key actions to prevent nutrition-related health problems such as malnutrition, obesity, and type 2 diabetes[1-3].

Recent epidemiological estimates reveal that globally, at least one in two children (56%) of preschool age has some micronutrient deficiency, corresponding to 372 million individuals[4]. The most deficient micronutrients in the pediatric population are iron, iodine, zinc, and vitamin A[4]. The global prevalence of these micronutrient deficiencies is variable: 28% for iodine, 18% for iron, 17% for zinc, and 15% for vitamin A[1,5,6]. The prevalence tends to be higher in middle and low-income countries, especially in East and South Asia, Sub-Saharan Africa, and the Pacific[4]. In Brazil, despite the scarcity of recent population studies on this issue, data from the School Health Assessment Survey (2015) showed a high prevalence of food insecurity (48%) and inadequate intake of zinc (48%) and iron (35%), among other micronutrients[7].

Hidden hunger syndrome (HHS) refers to the deficiency of essential micronutrients that affect children's health and development, even in the presence of an appropriate caloric intake. This deficiency occurs when the diet is inadequate in diversity and quality, resulting in deficiencies of important vitamins and minerals (*e.g.***,** iron, vitamin A, iodine, zinc, among others). The cause may be multifactorial, including low access to foods with adequate nutritional value, poor socioeconomic status, food selectivity, and environmental and cultural factors. The signs/symptoms resulting from HHS are difficult to identify during a common clinical examination, since they can be discreet and nonspecific, such as fatigue, drowsiness, difficulty concentrating, mood changes, and immunological dysfunctions. An accurate diagnosis may be established through a specific nutritional assessment and laboratory tests[1,8,9].

HHS is a chronic, silent, and devastating condition that may negatively impact physiological growth, cognitive development, and immune functions of children. In many cases, this condition is more prevalent in vulnerable populations, where access to nutritious foods is limited, increasing the risk of food insecurity and favoring the occurrence of other nutritional deficiencies[10,11]. HHS can be treated or prevented clinically through a balanced intake of foods that contain essential micronutrients for the physiological demands of the body[12]. Therefore, understanding intervention strategies is important to promote children´s healthy growth and full development. This review aimed to synthesize and present the current evidence on therapeutic interventions in children with HHS.

MATERIAL AND METHODS

This is a structured synthesis of the literature that is presented as a narrative review. The search and inclusion of primary studies on HHS was conducted through five steps: (1) formulation of the research question; (2) definition of eligibility criteria; (3) description of the search strategy to obtain original articles; (4) compilation of the data obtained; and (5) presentation of the results. The mnemonic PICO (population, intervention, comparison, and outcome) was used to identify eligible primary studies (**Table 1**).

The review was planned and conducted following the research question: "How to treat clinically children with HHS?". All primary and secondary outcomes were assessed, including clinical (*e.g.,* presence of diseases and physical/cognitive function), laboratory (*e.g.,* serum tests and nutritional biomarkers), and mortality data. The eligibility criteria were intervention studies published as full-text article in the last five years (2020–2024), including randomized clinical trials, quasi-experimental trials, or systematic reviews/meta-analyses of therapeutic interventions in pediatric populations (<18 years) with HHS.

Searches were performed in the PubMed database using the following terms/descriptors in English: “hidden hunger” AND “children”. Data extracted from the original articles were study (author/date), design, participants (sample), intervention (treatment), and outcome (variables/results). Articles whose studies were conducted with adult populations (≥18 years) were excluded. The results were summarized and presented descriptively in a Microsoft Word® table.

Table 1 - Mnemonic PICO (population, intervention, comparison e outcome).

P	**Population**	Children/adolescents under 18 years of age from the community or health institutions.
I	**Intervention**	Therapeutic (*e.g.*, supplementation and medication) and educational (*e.g.*, nutritional education and counseling).
C	**Comparison**	No intervention or maintenance of conventional food.
O	**Outcome**	Clinical (*e.g.*, physical/cognitive measures), laboratory (*e.g.*, serum micronutrient levels), and mortality.

RESULTS AND DISCUSSION

All full-text, original articles published between 2020 and 2024 (up to 11/28) that used therapeutic interventions in children with HHS, identified in the PubMed database through the combination of the terms/descriptors mentioned above, were considered for inclusion in this review. The searches resulted in 47 articles, of which five were included in this review because they were intervention studies. Three were randomized clinical trials, and two were systematic reviews, one with and one without meta-analysis[13-17].

The three randomized clinical trials were conducted in African countries (*i.e.,* Egypt, Malawi, and Ethiopia). One systematic data review was conducted in the Indian population, and the other was conducted in developed countries such as the United States, England, the Netherlands, Australia, and Chile, among others. In total, 500 children were included in the clinical trials. In one systematic review, sample sizes were between 23 and 24,291 children. The lowest and highest ages reported in the five included studies were zero and 15 years, respectively (**Table 2**). Daily intake recommendations for some micronutrients in children are presented in **Table 3.**

Two of the included articles showed a significant reduction in anemia among preschool and school-aged children[13,15]. This reduction can be attributed mainly to biofortified dietary supplementation with iron and folate, which are capable of restoring serum hemoglobin levels[18]. However, one of the included clinical trials did not show a significant difference in hemoglobin concentrations and the presence of anemia between the intervention and control groups in school-aged children (five and 10 years) who received selenium supplementation[16]. Other factors, such as follow-up period, duration of intervention, and age group of participants, may have influenced the therapeutic effects on hemoglobin levels and the prevalence of anemia.

The systematic review conducted by Haridas *et al.* (2022)[15] presented positive results on serum levels of micronutrients such as calcium, iodine, and zinc in infants, using supplementation strategies (*e.g.,* tablets and syrup) and food education (*e.g.,* information and counseling), carried out alone or in combination. Meals can be enriched with these minerals through dairy products and derivatives, red meat, and seafood. If these are not available, dark leafy vegetables (*e.g.,* kale and broccoli), legumes (*e.g.,* beans and lentils), and eggs can be suitable substitutes[18,19]. It is worth remembering that the minerals mentioned here play a crucial role in maintaining the health and well-being of children, preventing not only HHS, but also favoring musculoskeletal, immunological, and thyroid function[1,18,20].

Table 2. Characteristics of the articles included in the review (n=5).

Study	Design	Participants	Intervention	Outcome
Original studies				
Bassouni *et al.* (2022)[13]	Randomized controlled clinical trial.	- Community children aged between 3−9 years with mild and moderate anemia, divided into 2 age-matched groups (n=120): intervention (IG) and control (CG) group. - Inclusion criteria: absence of gastrointestinal disorders and use of antibiotics in the last 3 months; child's acceptance of supplementation; mother willing to complete the dietary assessment form and collect stool/urine samples.	- IG: supplementation containing Fe, Ze, Se, vitamins A, E, B (1, 2, 6, and 12), folate and niacin, provided through fried meatballs made with chicken liver, 3x/week for 90 days (n=60). - CG: no supplementation (n=60).	- Significant improvement in anemia in 100% of children <6 years and in 88% of children ≥6 years ($p<0.05$). - Significant increase in fecal systemic IgA, urinary hydroxyproline, and urinary I excretion in favor of IG ($p<0.05$). - Significant improvement in verbal and nonverbal cognitive function test scores (Wechsler scale) in favor of the IG ($p<0.05$).
Joy *et al.* (2022)[16]	Individually randomized, double-blind, placebo-controlled clinical trial.	- Schoolchildren from rural communities aged between 5−10 years (n=180). - Eligibility criteria: children living in the community, who have their meals at home and whose families agreed to receive the intervention.	- IG: corn flour biofortified with Se for a period of 8 weeks (n=90). - CG: corn flour not biofortified with Se (n=90).	- Significant improvement in serum Se levels in favor of the IG ($p<0.05$). - Significant decrease in the prevalence of Se deficiency in favor of the IG ($p<0.05$). - Absence of significant difference in hemoglobin concentrations and the presence of anemia between IG and CG. - Absence of significant difference in cases of diarrhea, vomiting, and pneumonia between IG and CG.

Muluye *et al.* (2020)[17]	Randomized, single-blind, controlled clinical trial, with pre- and post-test comparison.	- Children aged between 6−23 months (n=200). - Inclusion/ exclusion criteria: children from daycare centers who were old enough to receive complementary feeding were included; children whose mother had a mental illness identified during baseline data collection and/or a medical restriction on eating any food item were excluded.	- IG: nutritional education strategy through in-person lectures, informative printed material, and practical activities that included recipes and preparation of complementary foods, adequate quantity and frequency of meals, dietary diversification, and personal hygiene and sanitation; the intervention was carried out for 4 consecutive months, biweekly, with 2 hours per session (n=100). - CG: no intervention (n=100).	- Increase in the proportion of mothers with good knowledge about appropriate complementary feeding, from 59% in the pre-test to 96% in the post-test, in favor of the IG ($p<0.05$). - Increase in the practice of complementary feeding, from 54% in the pre-test to 86% in the post-test, in favor of the IG ($p<0.05$). - There was no difference in the knowledge and practice of complementary feeding in the CG after 4 months ($p>0.05$). - There was no significant difference in the knowledge and practice of complementary feeding between IG and CG in the pre-test ($p>0.05$). - There was a significant difference in the knowledge and practice of complementary feeding between IG and GC in the post-test, in favor of the IG ($p<0.05$).
Review studies				
Durão *et al*. (2024)[14]	Systematic review with meta-analysis.	- Community children aged ≥2 years, attending preschool, primary school, and secondary school (n between 23−24,291 children).	- IG: policy strategies/ interventions that positively influenced eating habits in and around schools (nutritional	- Included 74 studies reporting different comparisons, with low and very low uncertainty evidence. - Improvement of the food environment shows modest beneficial effects on some

			standardization to improve food quality; restriction of marketing for foods considered unhealthy; encouragement of healthy eating habits; cost reduction for healthy foods; and direct distribution of foods with high nutritional value such as vegetables and fruits), lasting between months and years. - CG: no intervention.	outcomes (dietary pattern, lifestyle habits, and anthropometric measures) in favor of the IG. - Increased availability of healthy nutrients, presentation/position of food during meals and provision of vegetables/fruits show a beneficial effect on the consumption of healthy foods/beverages in favor of the IG. - Dietary standardization, modification of the size of the portions served, and implementation of multiple behavioral strategies (encouraging healthy consumption) show a beneficial effect on energy intake in favor of the IG. - Modifications of the buying or selling behavior of healthy foods show inconsistent effects on the selection and consumption of healthier foods in favor of the IG.
Haridas *et al*. (2022)[15]	Systematic review.	- Infants, preschoolers, and school-aged children aged between 0−15 years. - Selection criteria: original intervention studies from India, published in peer-reviewed journals; studies published in languages other than English and before 2011	- IG: food-based approach through supplementation with value-added, synergistic, and micronutrient-enriched foods; fortified or biofortified	Infants: - Significant increase in serum levels of Ca, PO4, Fe, I, and Zn in favor of the IG. - Significant improvement in motor and mental development in favor of the IG. - Significant positive effect on

	were omitted; review studies, editorials, short communications, blogs and newsletters were excluded.	supplementation with micronutrients (tablets, syrups, powders, among others); community-based approach through educational, and behavioral strategies (information, awareness, counseling, among others); combination of the approaches mentioned above; duration of interventions between 3 months and 2 years. - CG: no or other intervention.	skinfold thickness in favor of the IG. - Positive effect on health and nutrition in favor of the IG. - Significant reduction in mortality risk in favor of the IG. Preschoolers/ schoolchildren: - Significant decline in the prevalence of anemia and Zn deficiency in favor of the IG. - No significant difference in Fe deficiency anemia between IG and CG. - Significant improvement in morbidity status with higher Zn intake in favor of the IG. - Significant improvement in vitamin D levels and bone mineral density in favor of the IG. - Significant improvement in serum levels of hemoglobin, folate, albumin, retinol, retinol-binding protein, ferritin, Fe, and Ca in favor of the IG. - Positive effect on health and nutrition in favor of the IG.

mcg RAE: micrograms of retinol activity equivalents. *Adequate intake per day. † Recommended intake per day.

In the same systematic review by Haridas *et al.* (2022)[15], a significant improvement in serum vitamin D levels and bone mineral density in preschool/school-aged children was reported with the use of the interventions mentioned in the previous paragraph. Vitamin D is essential for the organic absorption of calcium and phosphorus, which contributes substantially to the formation of bones and teeth in children. Additionally, it is necessary to highlight other functions of this vitamin, since it acts as a fat-soluble steroid hormone, performing as a cofactor for several enzymatic reactions through physiological signaling/modulation of the endocrine, immune, and cardiovascular systems. Vitamin D deficiency in children can compromise bone development and result in rickets, especially in geographic areas with little sun exposure. Other factors such as skin color, age, and the presence of diseases can affect the amount of vitamin D absorbed. Food sources rich in this vitamin may be difficult to obtain (*e.g.,* fatty fish such as salmon and sardines and cod liver oil), and the use of supplementation and/or sun exposure should be considered[1,21,22].

Two of the included articles, the clinical trial conducted by Bassouni *et al.* (2022)[13] and the systematic review carried out by Haridas *et al.* (2022)[15], showed significant improvement in cognitive function in infants and preschool/school-age children. In particular, the clinical trial demonstrated an increase in scores on the Wechsler Intelligence Scale for Children, which assesses intellectual capacity and problem-solving through verbal and non-verbal domains. The authors observed significant positive effects in practically all items assessed by the scale, including. reading ability, text comprehension, oral expression, object identification, visual recognition, and memory, after 90 days of supplementation with minerals and vitamins (*e.g.,* iron, zinc, vitamin A, and B complex). These micronutrients have a positive effect on the neurobiological processes that involve brain function, memory formation, concentration ability, motor behavior, and school performance[3,23,24].

A recent systematic review and meta-analysis evaluating the effects of oral iron supplementation on cognitive function in children/adolescents (aged 5–19 years) from low- and middle-income countries, which included nine original studies from five different countries and 1,196 participants, showed a significant increase in intelligence scores in favor of the intervention group (SMD=0.47, 95% CI=0.10−0.83; *p*=0.012). A meta-regression analysis showed that intelligence scores improved with increasing iron supplementation dose (OR=1.02, 95% CI=1.02−1.04; *p*=0.020). A subgroup analysis revealed that the beneficial effects of iron supplementation on intelligence scores were significantly greater in individuals aged >11 years compared to those aged ≤11 years (SMD=1.18, 95% CI=0.33−2.04; *p*=0.007). However, iron supplementation did not determine a significant difference in school performance between the intervention and control groups (SMD=0.42, 95% CI=-0.33−1.18; *p*=0.257)[23]. Cognitive problems resulting from mineral/vitamin deficiencies appear to be mainly important in the poorest regions of the world and vulnerable populations[3,8].

Only one of the included articles presented the mortality outcome. This was the systematic review by Haridas *et al.* (2022)[15], who reported a significant reduction in the risk of mortality in lactating women with the use of dietary supplementation. Specifically, the authors identified a randomized clinical trial in which a 10% reduction in the risk of death at six months was observed among newborns supplemented with vitamin A within 72 hours of birth. It is noteworthy that, although mortality has been insufficiently investigated in recent clinical studies, HHS is estimated to account for at least one-third of all childhood deaths annually[8]. The relationship between HHS and infant mortality involves multiple pathophysiological and clinically silent mechanisms, since at first clear signs/symptoms of nutritional deficit such as low weight or growth deficiency may not be observed. On the other hand, the lack of micronutrients can chronically compromise systemic functions and result in impairment of neurological development, physical capacity, and the immune system. The latter increases vulnerability to serious infectious conditions, which may culminate in fatal events[1,25].

The most common therapeutic strategies in the included articles were

Supplementation with fortified/ biofortified foods and use of educational/behavioral methods. Fortified foods are those in which vitamins and minerals are artificially added during their processing. Some examples are iodized salt, iron-fortified flour, and vitamin D-fortified milk. These foods are produced to improve the intake of essential micronutrients. Biofortified foods are grown naturally but contain higher levels of vitamins and minerals. This is achieved through genetic improvement and biotechnology techniques. Some examples are vitamin A-rich rice (golden), iron-rich beans (cowpea), and zinc-rich corn. Although both approaches have been used to treat HHS, there are important differences. While fortification depends on industrial processes and allows for broader large-scale implementation, biofortification enhances micronutrient content directly in crops, offering a more sustainable and long-term strategy that bypasses post-harvest interventions. However, biofortification may encounter barriers related to farmer adoption and consumer acceptance, often requiring local adaptations influenced by economic, environmental, and cultural factors [26-28].

Educational/behavioral methods aim to inform and engage families and communities on the importance of adequate nutrition for optimal child development. In addition, they promote changes in eating habits and daily meals through psychological and motivational approaches that encourage the adoption of healthy behaviors. Some of the educational and behavioral methods used in the included articles were nutritional education in schools through lectures, workshops, provision of educational materials and healthy cooking classes for children and/or parents/caregivers; family and community awareness campaigns on nutrition and healthy eating, restriction of advertising for foods considered unhealthy and reduction of costs for foods considered healthy; and encouragement to change eating habits through motivational and positive conditioning techniques aimed at children and/or parents/ caregivers. These resources can improve a wide range of outcomes related to HHS in children, either alone or combined with food supplementation, representing a simple, low-cost, and safe approach to promote micronutrient-rich dietary habits during childhood[14,15,17.]

Table 3 - Daily intake recommendations for some minerals and vitamins in children according to age group (0–8 years).

Micronutrient	Quantity	Source
Iron	0−6 months: 0.27 mg/day* 7−12 months: 11 mg/day† 1−3 years: 7 mg/day† 4−8 years: 10 mg/day†	https://ods.od.nih.gov/factsheets/Iron-HealthProfessional/ (Updated on October 9th, 2024)
Zinc	0−6 months: 2 mg/day* 7−12 months: 3 mg/day† 1−3 years: 3 mg/day† 4−8 years: 5 mg/day†	https://ods.od.nih.gov/factsheets/Zinc-HealthProfessional/ (Updated on September 28th, 2022)
Iodine	0−6 months: 110 mcg/day* 7−12 months: 130 mcg/day* 1−3 years: 90 mcg/day† 4−8 years: 90 mcg/day†	https://ods.od.nih.gov/factsheets/Iodine-HealthProfessional/#disc (Updated on November 05th, 2024)
Calcium	0−6 months: 200 mg/day* 7−12 months: 260 mg/day* 1−3 years: 700 mg/day† 4−8 years: 1000 mg/day†	https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/ (Updated on July 24th, 2024)
Vitamin A	0−6 months: 400 mcg RAE/day* 7−12 months: 500 mcg RAE/day* 1−3 years: 300 mcg RAE/day† 4−8 years: 400 mcg RAE/day†	https://ods.od.nih.gov/factsheets/VitaminA-HealthProfessional/ (Updated on December 15th, 2023)
Vitamin D	0−6 months: 400 UI/day* 7−12 months: 400 UI/day† 1−3 years: 600 UI/day† 4−8 years: 600 UI/day†	https://ods.od.nih.gov/factsheets/VitaminD-HealthProfessional/ (Updated on July 26th, 2024)
Vitamin E	0−6 months: 4 mg/day* 7−12 months: 5 mg/day* 1−3 years: 6 mg/day† 4−8 years: 7 mg/day†	https://ods.od.nih.gov/factsheets/VitaminE-HealthProfessional/ (Updated on March 26th, 2021)
Vitamin B12	0−6 months: 0.4 mcg/day* 7−12 months: 0.5 mcg/day* 1−3 years: 0.9 mcg/day† 4−8 years: 1.2 mcg/day†	https://ods.od.nih.gov/factsheets/VitaminB12-HealthProfessional/ (Updated on March 26th, 2024)

Some limitations of this review should be mentioned. First, although only randomized clinical trials and systematic reviews were included, the search was carried out in a database, where only five articles were identified, which did not undergo an appropriate assessment of methodological quality (*e.g.,* risk of bias) and did not have a quantitative synthesis of the primary data (*e.g.,* meta-analysis), which may lead to potential mistakes in the interpretation of the results. Second, there was a considerable scarcity of physical/anthropometric outcomes (reported in only two articles) and mortality (reported in only one article), which limits the generalizations of the review to clinical settings. Conversely, this review provides very current information on the nutritional management of micronutrient deficiencies in children, including possibilities of supplementation and food fortification/biofortification, while also outlining directions for future research.

CONCLUSION

HHS is a chronic and silent clinical condition that may seriously affect the growth, development, and functionality of children, especially in vulnerable populations and low-income regions. This review demonstrated that nutritional interventions such as micronutrient supplementation and food fortification/biofortification are effective for mitigating the effects of this nutritional deficiency, evidenced by the improvement of outcomes such as anemia, serum micronutrient levels, and cognitive function. Additionally, it was demonstrated that educational and behavioral methods can play a crucial role for promoting healthy eating habits. Although evidence shows a positive impact of nutritional interventions on several research domains, the scarcity of studies focused on important clinical outcomes (*e.g.,* mortality) limits the scope of the results.

The diversity of therapeutic approaches, such as iron, zinc, calcium, and vitamin A supplementation, in combination with educational/behavioral strategies, points to an integrated and promising approach to combating HHS in children. However, more robust studies with different clinical outcomes are needed to improve prevention and treatment programs for this condition that affects millions of children globally. In summary, adequate nutritional management, alongside educational initiatives and public policies that improve food accessibility, is essential to provide children's health and well-being, thus ensuring more equitable and health-promoting dietary practices for future generations.

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