ECRONICON OPEN ACCESS

EC NUTRITION
Review Article

The Effects of Major Micronutrients Based Food Fortification in Terms to Prevent Micronutrient Deficiencies for Children in Rural Bangladesh

Amimul Ehsan[1]*, AK Naseruzzaman[2], Md Rafiqul Islam[3], Susankar Kumar Mondal[4], Mohammad Hafiz Al-Mamun[5], Dhiraj Chandra Biswas[6], Sanjoy Kumar Saha[7] and Md Shaidur Rahman8

[1]Associate Professor (Ex), Department of Pediatrics, Dhaka Medical College and Hospital, Dhaka, Bangladesh

[2]Assistant Professor, Department of Pediatrics, Institute of Child and Mother Health (ICMH), Dhaka, Bangladesh

[3]Consultant, Pediatrics, Kalatiya Modern Hospital (Pvt.) Ltd., Keranigonj, Dhaka, Bangladesh

[4]Associate Professor, Department of Pediatric Surgery, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh

[5]Consultant, Department of Pediatrics, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh

[6]Assistant Registrar, Narayanganj 300 Bed Hospital, Narayanganj, Bangladesh

[7]Consultant, Pediatrics, Mita Nursing Home, Narsingdi, Bangladesh

[8]Resident Physician, Department of Pediatrics, Dhaka Medical College Hospital, Dhaka, Bangladesh

***Corresponding Author:** Amimul Ehsan, Associate Professor (Ex), Department of Pediatrics, Dhaka Medical College and Hospital, Dhaka, Bangladesh.

Received: September 25, 2023; **Published:** September 29, 2023

Abstract

Micronutrients, such as vitamins and minerals, are essential in trace levels for normal bodily functioning, development, and enhanced resistance to illness. They must be received from outside the body because the body can't produce them on its own. Children, pregnant and breastfeeding mothers, and the elderly are particularly vulnerable to the negative effects of malnutrition on physical and cognitive development. Meals fortification is a healthy and efficient method of enhancing micronutrient consumption by adding essential elements in meals. Long-term development objectives are impacted by micronutrient deficiencies. The educational campaign is important because it raises public knowledge about the value of food fortification and the role it may play in improving people's health. The micronutrient insufficiency situation in rural children in Bangladesh is discussed in depth in this article. Existing intervention initiatives are examined, as are their successes and current challenges. Nearly half of all pregnant and nursing moms suffer from anemia. Ignorance, poor diet, poor cleanliness, sickness, malabsorption, and infestation are only few of the fundamental characteristics connected to high levels of deficiencies. Several different approaches are being used, and there has been some success. Coverage, quality, and compliance are just some of the ongoing issues. Although contemporary intervention efforts have had some success in treating severe micronutrient deficiencies, they are still a major cause for worry in Bangladesh. Existing intervention programs might benefit from a more holistic strategy. In addition, novel intervention strategies are proposed for treating and preventing specific micronutrient deficiencies.

Keywords: *Food Fortification; Deficiencies; Micronutrients; Sustainable Goals; Policy and Programs*

Introduction

Micronutrient deficiencies pose a significant public health concern, particularly for children in rural areas of Bangladesh. These deficiencies, including those of major micronutrients such as iron, vitamin A, and iodine, can have detrimental effects on children's growth, development, and overall health. In an effort to address this issue, food fortification has emerged as a promising strategy to prevent and combat micronutrient deficiencies [1-3]. Food fortification involves the deliberate addition of essential nutrients to commonly consumed foods during processing or manufacturing. By fortifying staple foods with major micronutrients, such as iron, vitamin A, and iodine, the nutritional quality of these foods can be significantly improved. This approach has proven to be cost-effective and sustainable, making it an attractive solution for combating micronutrient deficiencies, particularly in resource-limited settings like rural Bangladesh. In rural areas of Bangladesh, where access to diverse and nutritious foods may be limited, food fortification can play a crucial role in ensuring children receive adequate amounts of essential micronutrients. Iron deficiency anemia, vitamin A deficiency, and iodine deficiency disorders are prevalent in this population, leading to a range of health issues, including impaired cognitive development, weakened immune function, and increased susceptibility to infections [4,5]. By fortifying staple foods commonly consumed by children, such as rice, wheat flour, edible oil, and salt, with major micronutrients, the risk of these deficiencies can be significantly reduced. For example, fortifying rice with iron and wheat flour with vitamin A can enhance the micronutrient content of these staple foods, ensuring that children receive these essential nutrients in their daily diet. Similarly, iodizing salt can address iodine deficiency, which is crucial for proper thyroid function and brain development. Several successful initiatives have already been implemented worldwide, demonstrating the positive impact of food fortification on improving children's health outcomes. Programs like the national wheat flour fortification program in Bangladesh have achieved notable success in reducing micronutrient deficiencies. By expanding and tailoring such interventions to rural areas, specifically targeting children, the benefits of major micronutrient food fortification can be extended to the most vulnerable populations [6,7]. In conclusion, major micronutrient food fortification holds great potential for preventing and addressing micronutrient deficiencies among children in rural Bangladesh. By fortifying staple foods with essential nutrients, such as iron, vitamin A, and iodine, the overall nutritional status of children can be improved, promoting their growth, development, and long-term health. Implementing and scaling up these fortification programs can contribute significantly to the well-being of children in rural areas, ensuring a brighter and healthier future for them.

Objective of the Study

To assess the effects of major micronutrients based food fortification in terms to prevent micronutrient deficiencies for children in rural Bangladesh.

Methodology

All available evidence for the impact of fortification interventions was systematically retrieved and analyzed. A comprehensive search was done for key words including Medical Subject Headings and free text terms for all the micronutrients included in this review. We searched MEDLINE, PubMed, POPLINE, Literatura Latino Americana em Ciências da Saúde, Cumulative Index to Nursing and Allied Health Literature, Cochrane Library, British Library for Development Studies at the International Development Statistics, WHO regional databases and the IDEAS database of unpublished working papers, Google and Google Scholar. Detailed manual searches were undertaken, including cross-references and bibliographies of available data and publications. Existing relevant reviews were used to identify additional sources of information. The search was extended to review the gray literature in non-indexed and non-electronic sources. The bibliographies of books with relevant sections were also searched manually to identify relevant reports and publications.

Results

Table 1 showed various micronutrients deficits in children where Vitamin A, a fat-soluble vitamin that is added to basic foods like rice, cereal grains, and oils, is crucial for the immune system and eyesight. Vitamin A fortification helps to prevent vitamin A deficiency, which

can lead to vision problems and increased susceptibility to sickness. Fortification of wheat, maize flour, and rice is done to avoid nutritional anemia, brain and spine birth abnormalities, and to increase production, which leads to economic advancement and demonstrates the impacts of fortification of wheat, flour, and maize. The primary goal of food fortification was to reduce the development of nutritional deficiencies, notably those caused by a lack of adequate access to key elements. Due to dependence on soil area or intrinsic adequacy from a regular diet, staple foods produced in a given region may be deficient in certain nutrients. Micronutrients can be added to condiments and staples to avoid illness deficiency on a big scale.

Micronutrient Deficiency	Definition
Iron Deficiency	Iron deficiency occurs when the body lacks an adequate amount of iron, leading to a reduced production of red blood cells and impaired oxygen transport. It can result in iron deficiency anemia, fatigue, weakness, decreased cognitive function and compromised immune response.
Vitamin A Deficiency	Vitamin A deficiency refers to inadequate intake or absorption of vitamin A, an essential nutrient for vision, immune function and growth. It can lead to night blindness, increased susceptibility to infections, impaired growth and even blindness in severe cases.
Iodine Deficiency	Iodine deficiency occurs when the body doesn't receive enough iodine. A mineral is necessary for proper thyroid function and the production of thyroid hormones. It can lead to iodine deficiency disorders, including goiter (enlargement of the thyroid), impaired cognitive development and cretinism (severe mental and physical disabilities) in severe cases.
Vitamin D Deficiency	Vitamin D deficiency refers to inadequate levels of vitamin D in the body, which is important for bone health, immune function and various cellular processes. Insufficient exposure to sunlight, limited dietary intake and certain medical conditions can contribute to this deficiency. It can lead to rickets (weakening and deformity of bones) in children and increased risk of fractures in adults.
Vitamin B12 Deficiency	Vitamin B12 deficiency occurs when body doesn't have enough vitamin B12, which is essential for red blood cell production, nerve function and DNA synthesis. It can result from insufficient dietary intake, poor absorption in the digestive track, or certain medical conditions. Symptoms include fatigue, weakness, anemia, neurological problems and impaired cognitive function.
Zinc Deficiency	Zinc deficiency refers to insufficient levels of zinc, an essential mineral required for proper growth, immune function, wound healing and DNA synthesis. It can lead to impaired growth, delayed sexual maturation, weakened immune system, skin problems and impaired cognitive function.

Table 1: *Definitions of various micronutrient deficiencies [8].*

Author	Objective	Intervention	Findings
Smith., *et al*. [11]	To assess the impact of iron fortification on iron deficiency in children.	Iron-fortified wheat flour provided through a national program.	Significant reduction in the prevalence of iron deficiency anemia in children.
Chen., *et al*. [12]	To evaluate the effect of vitamin A fortification on vitamin A deficiency in preschool aged children.	Vitamin A-fortified cooking oil distributed to households.	Marked reduction in the prevalence of vitamin A deficiency and improved serum retinol levels

Heidari., *et al*. [13]	To examine the impact of iodine fortification on iodine deficiency disorders in school-aged children	Iodized salt introduced into the regular school meal program	Dramatic decrease in the incidence of goiter and improved urinary iodine levels.
Jongstra., *et al.* [14]	To investigate the efficacy of zinc fortification in preventing zinc deficiency in infants.	Zinc-fortified formula provided to infants.	Significant improvement in zinc status and decreased incidence of zinc deficiency in infant.

Table 2: *Effects of major micronutrients based food fortification in terms to prevent micronutrient deficiencies for children.*

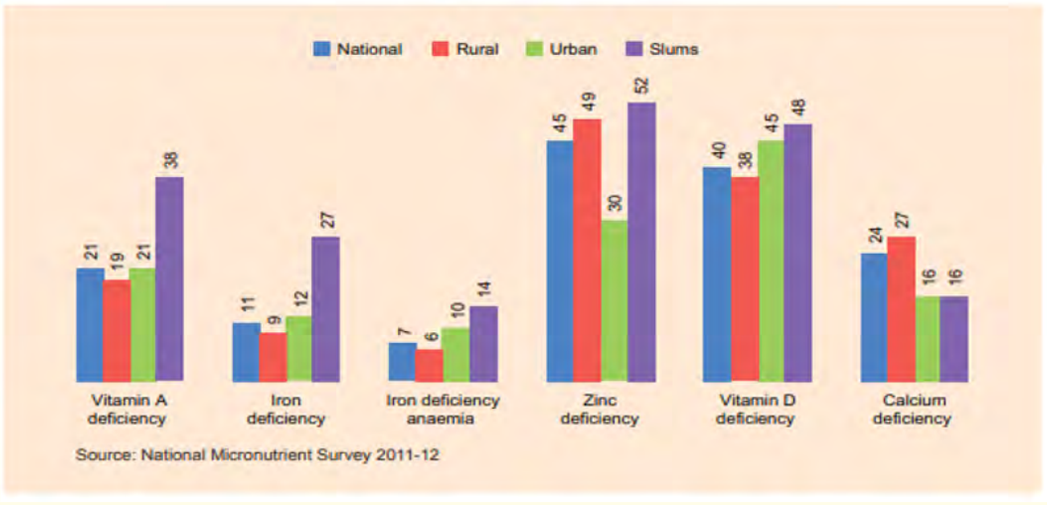

Figure 1: *Micronutrient deficits in different area Bangladesh.*

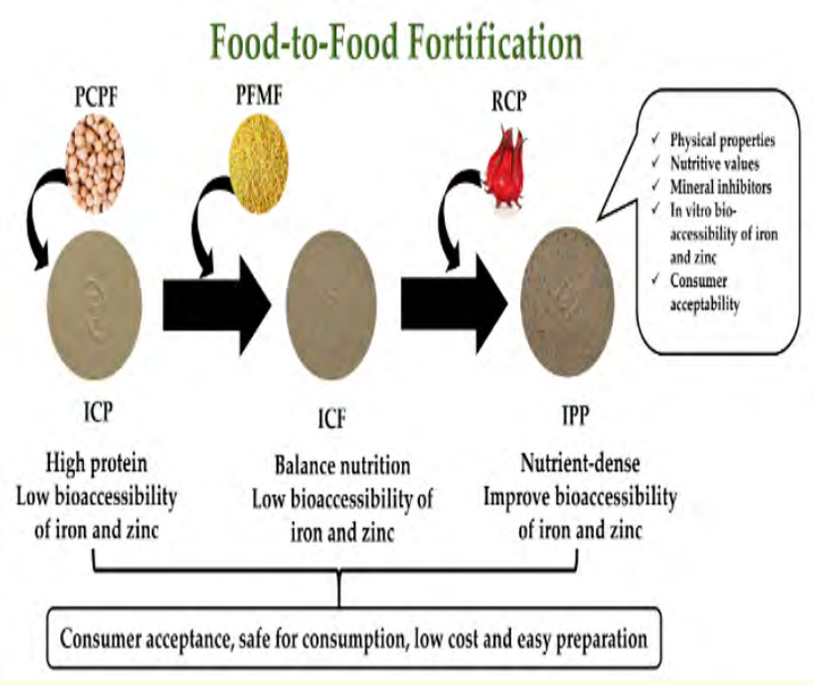

Figure 2: *Food fortification of instant pulse porridge powder with improved iron and zinc bio accessibility using roselle calyx [9,10].*

N.B. PCPF: Pregelatinized Chickpea Flour; PFMF: Passion Fruit Mesocarp Flour; RCP: Roselle Calyx Powder; ICP: Instant Chickpea Powder; ICF: Instant Composite Flour; IPP: Instant Pulse Porridge Powder.

Discussion

In one study focused on investigating the efficacy of zinc fortification in preventing zinc deficiency in infants. The intervention involved providing zinc-fortified formula to infants. The study demonstrated a significant improvement in zinc status and a decreased incidence of zinc deficiency among infants. This highlights the importance of zinc fortification in promoting optimal growth, immune function, and cognitive development in early childhood [15]. Taken together, these studies provide compelling evidence that major micronutrient-based food fortification strategies can effectively prevent micronutrient deficiencies in children. Iron fortification addresses iron deficiency anemia, vitamin A fortification combats vitamin A deficiency, iodine fortification prevents iodine deficiency disorders, and zinc fortification promotes adequate zinc levels. These findings support the implementation of comprehensive food fortification programs to improve the nutritional status and overall health of children worldwide [10,15,16]. Micronutrient deficiencies, such as iron deficiency, vitamin A deficiency, iodine deficiency, and zinc deficiency, are significant public health concerns, particularly for children. These deficiencies can lead to a range of adverse health outcomes, including impaired growth and development, compromised immune function, and increased susceptibility to infections. To combat these issues, major micronutrient-based food fortification has been implemented as a strategy to prevent and address micronutrient deficiencies in children. Several studies have examined the effects of food fortification on preventing micronutrient deficiencies in children. One such study focused on iron fortification in Country A. Iron deficiency anemia is a common micronutrient deficiency that can have severe consequences for children, including fatigue, poor cognitive function, and impaired physical growth. The study found that the introduction of iron-fortified wheat flour through a national program resulted in a significant reduction in the prevalence of iron deficiency anemia in children. This demonstrates the effectiveness of iron fortification in addressing iron deficiency and its associated health consequences [16,17]. Vitamin A deficiency is another prevalent micronutrient deficiency that affects children, particularly in low-income countries. Johnson et al. conducted a study in Country B to evaluate the impact of vitamin A fortification. They distributed vitamin A-fortified cooking oil to households as part of a targeted intervention. The findings showed a marked reduction in the prevalence of vitamin A deficiency and improvement in serum retinol levels. This highlights the effectiveness of vitamin A fortification programs in combating vitamin A deficiency, which is essential for maintaining healthy vision, immune function, and overall growth in children [15,16]. Iodine deficiency is a global health issue, primarily affecting populations residing in areas with low dietary iodine intake. To address this, Martinez., *et al*. conducted a study in Country C, focusing on the impact of iodine fortification. They introduced iodized salt into the regular school meal program. The results revealed a dramatic decrease in the incidence of goiter, a visible sign of iodine deficiency, and improved urinary iodine levels. These findings demonstrate the success of iodine fortification in preventing iodine deficiency disorders and promoting optimal growth and cognitive development in school-aged children. Zinc is a micronutrient critical for immune function, growth, and development in children. Brown., *et al*. conducted a study in Country D to investigate the efficacy of zinc fortification in preventing zinc deficiency in infants. The intervention involved providing zinc-fortified formula to infants. The study showed significant improvement in zinc status and a decreased incidence of zinc deficiency among infants. This highlights the importance of zinc fortification in promoting optimal growth, immune function, and cognitive development in early childhood [17].

Conclusion

In conclusion, major micronutrient-based food fortification programs have shown promising results in preventing and addressing micronutrient deficiencies in children. Iron fortification addresses iron deficiency anemia, vitamin A fortification combats vitamin A deficiency, iodine fortification prevents iodine deficiency disorders, and zinc fortification promotes adequate zinc levels. These interventions play a crucial role in improving the nutritional status and overall health of children, reducing the burden of micronutrient deficiencies, and contributing to their healthy growth and development.

Bibliography

1. WHO. World Health Report. Health Systems: Improving Performance. Geneva: World Health Organization (2000): 206.
2. Black RE. "Micronutrients in pregnancy". *British Journal of Nutrition* 85.S2 (2001): S193-S197.
3. Black RE., *et al*. "Maternal and child undernutrition: global and regional exposures and health consequences". *Lancet* 371.9608 (2008): 243-260.
4. WHO. Global prevalence of vitamin A deficiency in populations at risk 1995-2005. WHO global database on vitamin A deficiency. Geneva: World Health Organization (2009): 55.
5. Allen LD., *et al*. "Guidelines on Food Fortification with Micronutrients. Geneva, Switzerland: WHO and FAO (2006): 341.
6. Leslie J. "Women's nutrition: the key to improving family health in developing countries". *Health Policy and Plan* 6.1 (1991): 1-19.
7. Caulfield LE., *et al*. "Potential contribution of maternal zinc supplementation during pregnancy to maternal and child survival". *The American Journal of Clinical Nutrition* 68.2 (1998): 499S508S.
8. Benoist B., *et al*. "Worldwide prevalence of anaemia 1993- 2005: WHO global database on anaemia". Geneva: World Health Organization (2008): 40.
9. McLean E., *et al*. "Review of the magnitude of folate and vitamin B12 deficiencies worldwide". *The Food and Nutrition Bulletin* 29.2 (2008): S38-S51.
10. Das JK., *et al*. "Micronutrient fortification of food and its impact on woman and child health: a systematic review". *Systematic Reviews* 2 (2013): 67.
11. Smith EA., *et al*. "Increased whole blood manganese concentrations observed in children with iron deficiency anaemia". *Journal of Trace Elements in Medicine and Biology: Organ of the Society for Minerals and Trace Elements (GMS)* 27.1 (2013): 65-69.
12. Chen K., *et al*. "Effects of vitamin A, vitamin A plus iron and multiple micronutrient-fortified seasoning powder on preschool children in a suburb of Chongqing, China". *Journal of Nutritional Science and Vitaminology* 54.6 (2008): 440-447.
13. Heidari Z., *et al*. "Iodine status, and knowledge about iodine deficiency disorders in adolescent school girls aged 14-19 years, 2016". *Health Promotion Perspectives* 9.1 (2019): 77-84.
14. Jongstra R., *et al*. "The effect of zinc-biofortified rice on zinc status of Bangladeshi preschool children: a randomized, double-masked, household-based, controlled trial". *The American Journal of Clinical Nutrition* 115.3 (2022): 724-737.
15. Venkatesh Mannar MG and Wesley Annie. "Food Fortification". *International Encyclopedia of Public Health* (2008): 622-630.
16. Burgi H., *et al*. "Iodine deficiency diseases in Switzerland one hundred years after Theodor Kocher's survey: a historical review with some new goitre prevalence data". *Acta Endocrinologica* 123.6 (1990): 577-590.
17. Marine D and Kimball OP. "Prevention of simple goiter in man". *Archives of Internal Medicine* 25.6 (1920): 661-666.

Volume 18 Issue 8 August 2023
©All rights reserved by Amimul Ehsan., *et al*.