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Review Article

The Science of Food Fortification in Improving Health Challenges Due to Iron Deficiency Anemia and Zinc Deficiency for Children Under 5 Years in Bangladesh

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Abstract: For growth, the development of the brain and body, and disease resistance, trace amounts of micronutrients, such as vitamins and minerals, are required. The body cannot synthesis them, thus they must be obtained by diet and other means. Poor physical and mental growth, mental retardation, and blindness are all effects of malnutrition in susceptible populations such newborn infants, pregnant and nursing mothers, and the elderly. By adding essential components to food, food fortification is a secure and efficient method for increasing micronutrient consumption and restoring amounts lost during processing. Long-term development goals are impacted by micronutrient deficiencies. Anemia affects over half of all expectant and nursing mothers. Only a few of the essential traits linked to high degrees of insufficiency include inadequate nourishment, bad hygiene, illness, and infestation. Despite the promotion of a number of techniques and treatments, serious problems with coverage, quality, and compliance still exist. Micronutrient deficiencies continue to be a significant issue in Bangladesh despite the fact that current intervention attempts have had some success addressing severe deficits. Humans cannot survive without some essential micronutrients such as iron and zinc, which can only be obtained from diet. Food-based therapies require a creative strategy in order to increase dietary diversity, decrease nutritional losses, and increase nutritional bioavailability. The efforts of many developing countries have demonstrated that long-term, cost-effective solutions to the problem of micronutrient deficiencies in individuals may be found in food-based approaches. Strategies to address the issue of micronutrient deficiencies of iron and zinc will essentially be ineffective without proper attention is devoted to preventing communicable diseases like diarrhoea, decreasing morbidity, and improving basic health care facilities. Expanding food-based strategies has a number of advantages, including bettering nutritional health, raising incomes, and increasing access to and availability of a variety of foods rich in micronutrients, all of which will improve micronutrient status for both individuals and the community as a whole.

Keywords: Micronutrient Deficiencies, Iron and Zinc Deficiency, Food Fortification, Strategies and Policies

1. Introduction

For proper cellular and molecular function, micronutrients (vitamins and minerals) are necessary and play a significant role in the diet. [1] Even though they are only needed in minimal amounts, micronutrient deficiencies can have a wide range of harmful health effects. Due to inadequate food consumption, a lack of dietary diversity, and poor nutrient absorption brought on by infection, inflammation, and chronic illness, micronutrient deficiencies are particularly common in low- and middle-income countries (LMICs). [1] Concurrent impairments occur often as well. Due to their rapid growth and development, children under the age of five are particularly vulnerable. [1] They also have a higher need for micronutrients. The prevalence of anemia in children under the age of five is estimated to be 43%, [2] vitamin A deficiency in children under the age of five in LMICs is estimated to be 29%, [3] iodine deficiency is estimated to be 30% in school-aged children [4], and zinc deficiency is estimated to be 17% of the population. [5] Assessing micronutrient status in children under the age of five is challenging, especially in LMICs, due to a lack of resources, disparate definitions and methods for evaluating nutritional status, and incorrect aggregation of country-level data. Micronutrient deficits are associated with physical, developmental, and cognitive impairment, increased susceptibility to infections, higher morbidity and mortality, and reduced productivity later in life. [6-9] For instance, iron deficiency anemia has been associated with impaired motor growth and long-term cognitive deficits in early childhood, both of which impede learning and reduce educational attainment. [7, 10] Iodine deficiency in children has been associated with developmental delay. [11] Lack of vitamin A increases the risk of blindness in children and the death rate from common diseases like measles and diarrhea. [12] As a result of impaired immune response and stunted growth, zinc deficiency has also been linked to stunting, wasting, and more serious infections. [13, 14] According to estimates, undernutrition causes 3.1 million deaths annually, or 45% of all pediatric fatalities, including micronutrient deficiencies, stunting, and wasting. [15]

An equal number of people die each year from vitamin A inadequacy and iron deficiency, according to figures from the WHO. Treatment for nutritional deficiencies such goiter, rickets, beriberi, and pellagra may involve food fortification. The consequences of emerging deficiency, zinc deficiency, and selenium cancer promotion are not only health-related but may also have a financial impact due to physical and mental problems that reduce employment productivity. Emergent deficiency causes neural tube defects, zinc deficiency hinders child development, and selenium promotes cancer. According to a 2013 Lancet series on maternal and child nutrition, 1.9 billion people, or 28.5% of the world's population, suffer from iodine insufficiency. While the World Health Organization believes that iodine deficiency, which is defined as having a urine iodine level of 50 to 99 ug/L, causes mental damage in around 50 million people (WHO 2011c). In 2012, more than 34 million infants were shielded from the long-term effects of brain damage caused by iodine deficiency. (Data from UNICEF) Additionally, iron deficiency causes the anemia that affects 1.62 billion individuals. The situation is significantly worse in underdeveloped nations, where several micronutrient deficiencies frequently arise concurrently as a result of low vitamin concentration and bioavailability in meals. Micronutrient deficiencies may happen to anybody at any age, but they are more prevalent in young children and women who are pregnant or nursing because they require more micronutrients to support development and reproduction.

Wheat, wheat products, maize, rice, milk and milk products, salt, sugar, rehydrating oils, sauces, and breakfast cereals are the foods that are fortified the most frequently. They offer methods for delivering micronutrients and are cost-effective in developing countries like Bangladesh, India, Sri Lanka, and others. The US Preventive Services Task Force updated their advice in 2009. These tactics were widely employed in affluent nations, and many middle-income nations adopted them. [13] Due to a diversified diet and the consumption of fortified goods including juices, salt, wheat, margarine, sugar, and milk, nutritional deficiencies have been eliminated in wealthy nations. The majority of people in Bangladesh consume diets that are inadequate in one or more micronutrients, including zinc, iron, iodine, and vitamin A. Micronutrient bioavailability is low among the poor due to their high consumption of plant-based foods, notably for iron, zinc, and vitamin A. Poor dietary quality, not quantity, is the most important predictor of low micronutrient status in this population. Children under age five and mothers who are pregnant or nursing are more likely to experience micronutrient deficits.

The incidence of micronutrient insufficiency is very significant and is regarded as a severe public health concern despite several initiatives over the years to address the issue. The National Micronutrients Status Survey 2011-2012 has provided a chance to look at the nation's present micronutrient status for women and children, as well as the advantages and disadvantages of the programs that are already in place. In addition to demonstrating the short- and long-term effects on children's psychomotor development, this article attempted to concentrate on the effectiveness of important micronutrient supplementation in infancy.

1.1. Complimentary Feeding

For the benefit of infants' and children's futures as well as the development of the society they live in, optimal growth and development must be maintained. [14] As a result of poor feeding habits, such as the discontinuation of exclusive breastfeeding and the early introduction of weaning foods, children may experience malnutrition. Major contributing factors include poor nutrition later in infancy. [15] Studies have connected household food insecurity to the likelihood of stunting and underweight in preschoolers, as well as detrimental consequences on development and learning ability. [15, 16] Security in the home's food supply has also been linked to children's greater development. [14] Children between the ages of 6 and 24 months are frequently the target of complementary/supplementary food therapy since young children are most likely to have developmental issues, micronutrient deficits, and infectious diseases. [7] The preschool years (ages 1-4) represent a period of significant and fast postnatal brain development (sometimes referred to as neural plasticity), as well as the formation of fundamental cognitive abilities (i.e., working memory, attention, and inhibitory control). Programs that concentrate on specific nutritional deficits might not be as effective or long-lasting as a food-based, all-encompassing strategy. Moms must make difficult choices regarding when and how to start supplementary feeding since there are numerous factors that might impact it. Understanding the decision-making process, social beliefs, knowledge, attitude, and supplementary feeding practices is essential before devising an intervention strategy to prevent childhood malnutrition. Poor eating habits, including breastfeeding and supplementary feeding, as well as a lot of infectious diseases are the main proximal causes of malnutrition in the first two years of life.

A child's optimal IYCF protects them from both under- and over-nutrition as well as the long-term repercussions of either. Breastfeeding is a low-cost treatment for obesity, according to reviews of several research. [17, 18] Breastfed infants had a lower risk of acquiring asthma, diabetes, heart disease, high cholesterol, and other cardiac risk factors compared to newborns who were artificially fed, as well as malignancies including childhood leukemia [19] and breast cancer later in life. [20] Given the significant link between poor food quality and obesity, effective supplemental feeding may help people stay underweight and obese by providing a variety of nutrient-dense meals. For nations that are going through a nutrition transition1 and are dealing with a double burden of malnutrition, it is even more important to make sure that investments are made in children under the age of two to lower the risk of stunting and obesity (both under and over-nutrition). Rapid weight increase during the first two years is necessary for neonates were previously underdeveloped in order to prevent long-term undernutrition and lower morbidity and death. Rapid weight growth in later childhood is not ideal if a kid is unable to catch up before the age of two since it considerably raises the risk of chronic illness. The worst-case scenario for chronic illnesses, such as cardiovascular and metabolic issues, is a low birth weight infant who is stunted and underweight throughout childhood and adulthood before becoming overweight.

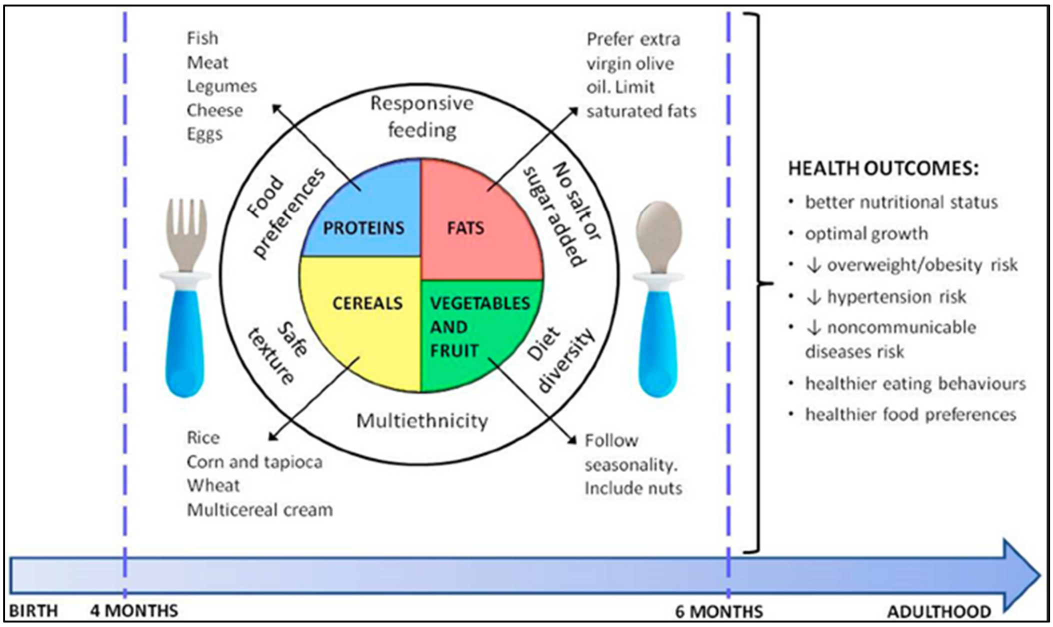

Figure 1. *Complimentary Feeding.*

1.2. Benefits of Food Fortification

According to the World Health Organization, food fortification is the addition of one or more ingredients to food, whether they are already present or not, in order to prevent or treat a known deficiency linked to one or more ingredients in the general population or specific groups of the general population. The procedure of choosing widely consumed and centrally processed items in order to guarantee fortification throughout the food's production and distribution is known as food fortification. Since a larger portion of the population consumes them, condiments and simple foods are excellent fortification alternatives. Vitamins A, D, iodine, iron, zinc, folic acid, and the B-complex vitamins can all be used to fortify food. Broadly speaking, fortification of staple foods is cost-effective. By fortifying a few pricey basic commodities, it is possible to increase the distribution of micronutrients across the population, particularly among the poor. Targeted fortification is the fortification of foods that are consumed by certain demographic groups, such as newborns, and result in higher consumption for that group. Focused discussion is given to young children's meal fortification supplements. Micronutrients that the majority of the population need are the focus of mass and targeted fortification. [5] The three most often utilized food vehicles are staples (wheat, oils, and rice), condiments (salt, soy sauce, and sugar), and prepared foods (noodles, newborn supplementary meals, and dairy products). The immune system and eyesight depend on the fat-soluble vitamin A, which is present in everyday foods including rice, cereal grains, and oils. Fortification with vitamin A aids in preventing vitamin A deficiency, which can impair vision and increase susceptibility to disease. In order to avoid nutritional anemia, birth deformities of the spine and brain, and to increase productivity, wheat, maize flour, and rice are fortified. All of these factors promote economic growth and emphasize the benefits of fortification of these grains.

Table 1. *Role of vitamins and minerals used in flour and rice fortification includes.*

Micronutrients	Functions
Folic acid (vitamin B9)	Reduces neural tube birth defects
Zinc	Strengthens immune system
Niacin (vitamin B3)	Prevents Pellagra, a skin disease
Riboflavin (vitamin B2)	Boosts carbohydrates, proteins and fats metabolism
Thiamine (vitamin B1)	Prevents beriberi, a nervous system disease
Vitamin B12	Enables functioning of the brain and nervous system
Vitamin D	Improves bone health by allowing absorption of calcium
Vitamin A	Childhood blindness and lowers the ability of individual’s to tackle infections
Calcium	Makes bones stronger, helps nerve muscles to transmit messages, functioning of muscles and blood clotting
Selenium	Helps in thyroid gland functioning and reproduction
Vitamin B6	Metabolism involving enzyme reactions

Food fortification was primarily done to avoid nutritional deficiencies, especially those brought on by improper access to essential elements. Due to soil conditions or inherent adequacy from a regular diet, staple foods grown in a particular region may be deficient in specific nutrients (UN, 1995). To prevent widespread illness shortage, micronutrients may be added to condiments and staple foods. Another benefit of food fortification is that it makes it less expensive to ship perishable foods like meat, dairy, and produce to remote areas of the globe. The governments of the United States and Europe forbid fortification of unprocessed foods as well as fortification of meat, poultry, and fish products (UN, 1995). There is a high frequency of vitamin D insufficiency in many nations since many individuals do not get enough vitamin D through their foods and the majority do not get enough sunshine. [15] Yogurt, bread, spaghetti, and juice are a few examples of foods enriched in vitamin D. Equal amounts of vitamin D are bioavailable in fortified foods and pharmaceutical preparations, and fortified meals raise 25-hydroxyvitamin D and vitamin D blood levels [15]. Fortification is effective because it increases the nutritional value of frequently consumed meals rather than requiring individuals to alter their behavior.

2. Micronutrient Deficiency in Bangladesh

Worldwide, 2 billion people suffer from micronutrient deficiencies, which can affect people of all ages and genders. Decreased infection resistance, metabolic abnormalities, and delays in physical and psychomotor development are just a few of the non-specific physiological problems that micronutrient insufficiency has been linked to. Worldwide, vitamin A deficiency was found to affect 21% of children, and it was found to be associated with higher rates of malaria, measles, and diarrheal disease mortality. Around 800,000 infant and expectant deaths worldwide, as well as 1.8 percent of all eye conditions, are attributed to vitamin A deficiency. A child's healthy growth and development may be significantly impacted by inadequate micronutrient consumption, especially during critical growth years. Initial effects of micronutrient deficiencies are minimal, but they steadily worsen with time, resulting in physical symptoms or clinical indications (DGHS, 2012). Worst of all, by the time symptoms appear, the harm has already been done. Some of these impacts and repercussions, including the child's cognitive development being hampered, are long-lasting.

Micronutrients including vitamin A, iron, iodine, and/or zinc are notably deficient in the typical Bangladeshi diet. In this cohort, poor dietary quality, not quantity, is the most significant predictor of decreased micronutrient status. [2] Micronutrient deficits are more common in young children, pregnant and lactating women, and the elderly. According to the National Micronutrient Survey (NMS) 2011-12, many preschoolers are lacking in a range of micronutrients, with one out of every five preschoolers having insufficient levels of vitamin A. Two out of every five preschoolers have vitamin D insufficiency, compared to 44% of preschoolers who need zinc. One-third of preschoolers have anemia, with 7.2% of them having iron deficiency anemia, while 24.4% of them had calcium insufficiency. [10] Household food insecurity, poor diet quality (predominantly plant-based foods with minimal animal foods), poor dietary diversity, ignorance of food value and diversity, intra- and inter-household disparity, gender inequality and inequity, and a lack of social positioning of vulnerable and marginalized populations are identified as the main underlying causes of micronutrient deficiencies in all segments of the population. [5] Being a slum dweller or a rural resident; lacking access to affordable, diversified foods, especially animal food sources; and lacking awareness of the health risks of deficiencies and the benefits of adequate micronutrient intake. Increased rural-to-urban migration and population density, which are accompanied by a lack of basic living standards (water, sanitation, etc.).

Micronutrient	Deficiencies can lead to
Iron	• Iron-deficiency anaemia; associated with retardation in growth and cognitive development
Vitamin A	• Growth retardation of foetus/baby, along with various types of congenital malformations • Eye-related problems, e.g. night blindness, impaired vision (including blindness)
Iodine	• Abnormal growth and development that may cause mental retardation or brain damage • Prolonged deficiency can cause goitre or enlarged thyroid gland
Calcium & Vitamin D	• Poor bone density, leading to skeletal deformations or easily fractured bones • Calcium deficiency may lead to stunting
Zinc	• Impaired growth & development of infants, children and adolescents • Weakened immune system, leading to increased susceptibility to infections and higher risk of mortality

Figure 2. *Micronutrient.*

2.1. Iron and Anemia Deficiency

According to the NMS 2011-2012, anemia is defined as a Hb concentration of 120 g/l in NPNL women and 110 g/l in children aged 6-59 months. This means that 33% of children aged 6-59 months and 26% of NPNL women had anemia. [18] These numbers show a considerable decline from 1997-1998 (47% in children aged 6-59 months and 45 percent in NPNL women) to 2003 (55.7% in children aged 6-59 months and 45% in NPNL women). Due to a lack of iron, anemia is characterized by pale inner eyelids, nailbeds, gums, tongue, lips, and skin. Additional indications and symptoms include exhaustion, headaches, and shortness of breath. Children and expectant mothers have been demonstrated to be particularly susceptible. A lack of iron can cause maternal and newborn mortality.

2.1.1. Lack of Iron in Complimentary Feeding

Anemia: A disease known as anemia occurs when the blood's hemoglobin content falls below a certain threshold, reducing red blood cells' ability to transport oxygen.

2.1.2. Outcomes of Anemia

1) Poor immune function and
2) Poor physical growth
3) Impaired learning and school achievement
4) Increased morbidity from infection
5) Fatigue and lower physical work capacity

2.1.3. Causes of IDA (Iron Deficiency Anemia)

1) Demand for iron is high
2) Complementary feeding is inappropriate
3) Nomeasures for controlling anemia in children

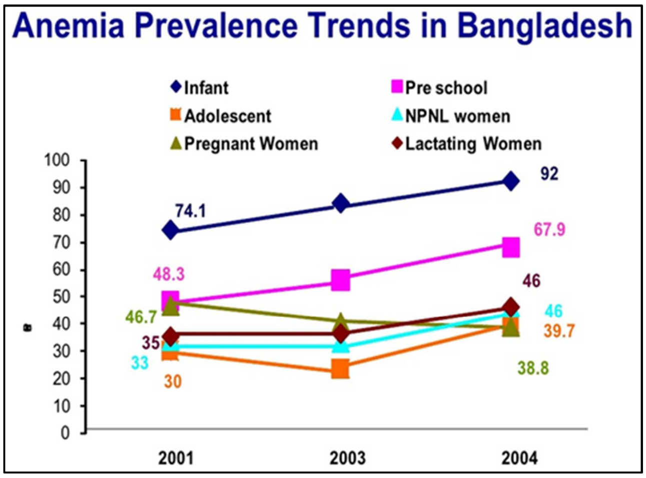

Figure 3. *Causes of IDA (Iron Deficiency Anemia).*

2.2. Importance of Zinc

Zinc is a trace mineral, yet it is necessary for almost 100 enzymes to carry out vital chemical reactions which needs small amounts. For growth of cells, building proteins, healing damaged tissue, and supporting a healthy immune system it is a major player in the creation of DNA., Adequate zinc is required during times of rapid growth because it helps cells to grow and multiply, such as childhood, adolescence, and pregnancy. It is also involved with the senses of taste and smell.

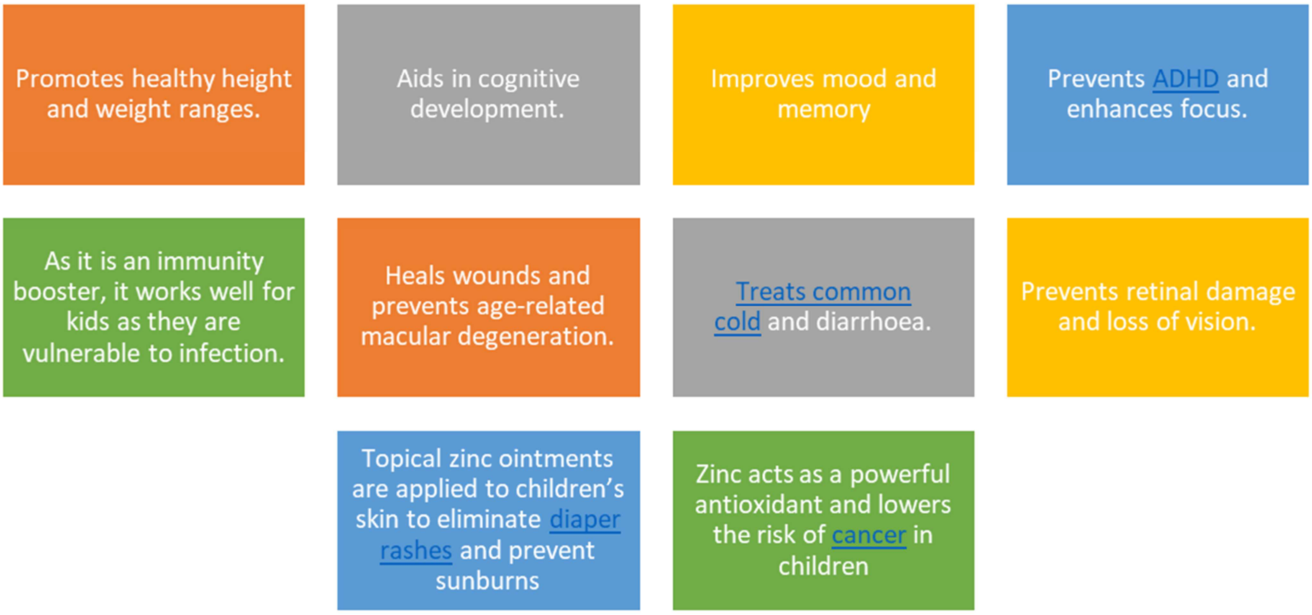

Figure 4. *Importance of Zinc.*

2.3. Deficit in Zinc

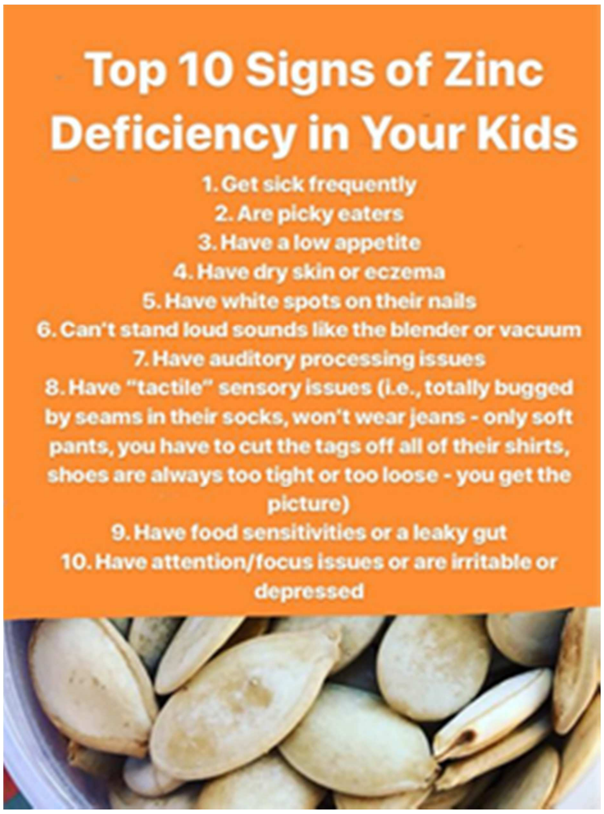

Figure 5. *Deficit in Zinc.*

According to the NMS 2011-2012, Zn insufficiency affects 44.6% of preschoolers and 57.3% of NPNL women, with the slums having the highest percentage. 23 Zn deficiency is defined as a serum quantity of 109 mmol/l in preschool-aged children and 101 mmol/l in NPNL women, according to the International Zinc Consultative Group. A high incidence of low serum Zn is regarded to be a reasonable indicator of a very severe shortage since serum Zn is homeostatically maintained and incapable of detecting marginal deficits. Poor Zn nutrition is caused by a combination of low socioeconomic level, family food insecurity, low consumption of animal sources of Zn, and a high intake of plant-based diets rich in phytate (a Zn absorption inhibitor). [10]

2.4. Micronutrient Malnutrition's Etiology

Most of the food consumed in Bangladesh is plant-based. They consume only a little amount of animal products, such as milk, eggs, and milk derivatives, and their nutritional variety is limited. As a result, a diet of poor quality and low bioavailability may be the main cause of micronutrient deficits in the nation. A study of dietary micronutrient intake among young children and their primary female careers in rural Bangladesh found a significantly low overall mean prevalence of micronutrient adequacy in children (43%) and women (26%) based on estimated average needs, [19] The main underlying causes of micronutrient deficiencies in the nation are low levels of knowledge about a proper diet and hygiene habits, illness, and infestation. [21]

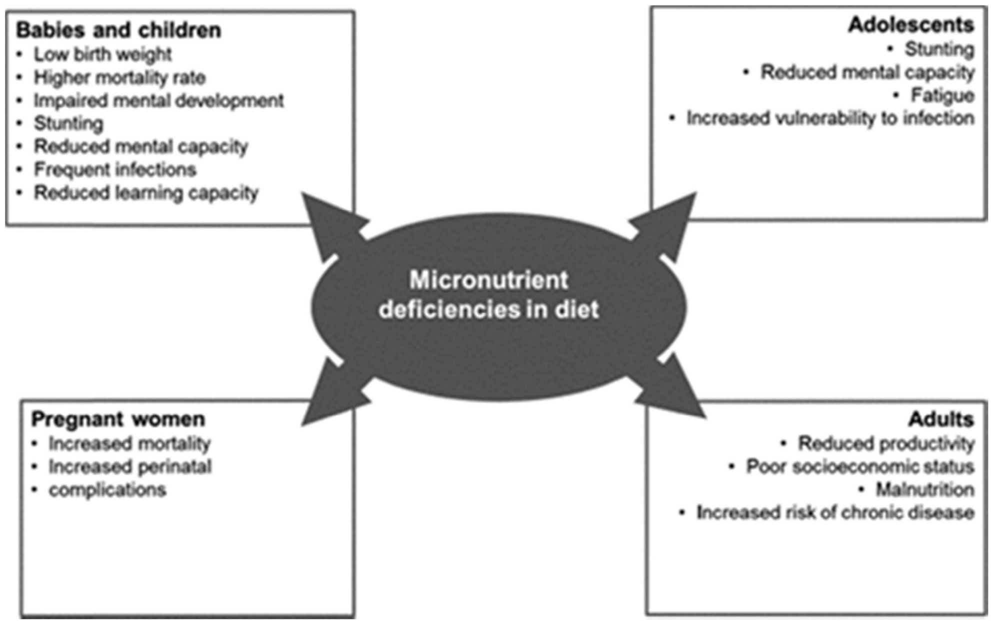

Figure 6. *Micronutrient Malnutrition's Etiology.*

3. Role of Iron and Zinc Supplementation

3.1. Iron Supplementation

Iron deficiency is the primary cause of anemia, which affects 25.4% of school-aged children and 47.4% of young children globally. As a result, one of the most prevalent but unrecognized nutritional deficiencies globally is iron deficiency anemia. Similar conclusions have been reached by several studies on the impact of iron shortage in youngsters. It has been demonstrated that it has a deleterious effect on both short-term and long-term motor, cognitive, social-emotional, and neurophysiologic outcomes in infancy and childhood. [19-22] Early iron deficiency is characterized by altered hippocampus energy metabolism, altered striatal dopamine metabolism, and decreased myelination. [23] The necessity for paying more attention to the developmental effects of prenatal iron deficiency is further highlighted by recent studies. Fetal and neonatal iron deficit has a deleterious effect on developing brain-behavioral systems, and maternal iron deficiency is the most common cause of reduced iron supply to the newborn. [18] Even when stratified by baseline hemoglobin content, iron had no impact on the rate of length or weight gain in babies aged 6 to 12 months in Bangladesh. In a secondary analysis of 6-month-old Indonesian infants taking part in a randomized trial, Lind et al. discovered that weight-for-age Z score (WAZ) from 6 to 12 months and mean WAZ at 12 months were significantly lower in the iron-replete iron-supplemented group compared to iron-replete non-iron-supplemented infants. Another recent randomized trial on breastfed kids recruited at 1 month and supplemented from 4 months found a relationship between medication iron and a minor but significant decrease in length increase and a tendency toward poorer weight growth at the end of supplementing at 9 months.

3.2. Supplementation with Zinc

Zinc is involved in the action of nearly 200 enzymes, including those involved in DNA and RNA synthesis. Zinc deficiency affects 17.3% of the world's population. [11] Although zinc is required for normal development both before and after birth, its function in the brain is unknown. Zinc deficiency during pregnancy and breastfeeding causes permanent cognitive damage in animals. [3] Zinc deficiency in babies may affect cognitive behaviors including activity and attentiveness.

3.3. Major Impact of Iron & Zinc Deficiency in Children

Deficits in micronutrients are relatively common worldwide. They are known to affect growth and health, but in this study we will focus on their contribution to the development of behavior and cognition. We will briefly go through several studies that have been done on vitamin deficiencies. We'll also give kids our full attention. Although research on these micronutrient deficits is limited, they may also affect behavior. The research of the effects of certain dietary deficiencies on behavior is fraught with difficulties. Shortages are more prevalent in relatively impoverished locations and are frequently connected to diseases, protein energy malnutrition, and other nutritional deficiencies in developing countries. All of these factors might influence how people behave, but some of them might interact with one another and change the effect. The only really effective way for demonstrating a causal relationship between a deficit and behavioral development is to carry out randomized treatment trials in populations with deficits due to the numerous confounding factors. Animal studies are also helpful, but it's important to use caution when applying the findings to humans. Anemia affects 46-51% of young infants in undeveloped countries, vs 7-12% of young children in wealthy nations1. Anemia is still prevalent in the UK, with rates as high as 39% in children living in inner cities, despite recent declines in the frequency of the condition in numerous wealthy countries. [2] Iron deficiency, which is brought on by a diet lacking in bioavailable iron and/or significant blood loss as a result of parasite infections, is the most common cause of anemia. Anemia is most prevalent between the ages of 6 and 24 months and is most vulnerable during periods of rapid growth. However, there is a very substantial risk to some very polluted groups of youngsters. Reduced productivity and reduced work capacity are both seen in adults as well as children with iron deficiency anemia[3], respectively. Since the late 1960s, there has been a substantial amount of research into the relationship between altered behavior, diminished cognition, and iron deficiency anemia. The ethical issues with placebo-anemic groups are removed by preventive research. Six preventive trials randomly assigned children to iron treatment or a placebo during the early months of life, before anemia became noticeable. On two recent studies that revealed no benefit, there are no specifics. Young Chileans who are not anemic. Recently, Lozoff [12] talked about the mechanisms connecting iron deficiency to behavior. Additionally to long-term changes in neuromaturation, altered neurotransmitter function, and "functional isolation," poor surroundings might have immediate negative effects. Despite treatment, an iron deficiency during the rat's peak period of brain growth led to a permanent reduction in the amount of iron in the brain. Iron is necessary for myelination, and hypomyelination occurs in iron-deficient rats. Additionally, there are altered dopaminergic and serotonergic neurotransmission as well as long-lasting abnormalities in dopamine receptors in the brain. These discrepancies are thought to be caused by behavioral adjustments and arousal. Rats lacking in iron have aberrant stress responses [25]. Delayed auditory evoked potentials are present in children with iron deficiency anemia and may be linked to hypomyelination since they persist even after the anemia is treated. Children who are anemic often show more hesitation, despair, dread, and weariness. They interact with their environment less, spend more time with their mothers, and are more likely to be carried. When their children are assessed, their mothers are less supportive and enjoy playing less. [12] Given that the testers' responses to anemic children during developmental examinations varied, it's probable that some of the mothers' actions are a response to the child's developing behavior. It is considered that children who are undernourished in protein and energy behave similarly and "functionally disconnect" themselves from their environment, which is detrimental to their development. The true prevalence of zinc deficiency is uncertain since it is challenging to measure zinc levels in the general population; nonetheless, it is likely to be prevalent. People with diets high in substances that hinder absorption, such as phytates, fiber, and cow's milk, are more likely to suffer from zinc insufficiency. Periods of rapid development, such as childhood, puberty, and pregnancy, enhance the need for zinc. Additionally, significant zinc losses are caused by parasite infections such diarrhea. [24] Although zinc deficiency is more frequent in children in underdeveloped countries, it may also happen in developed nations. [25, 26] Zinc deficiency has been associated with growth retardation, poor taste and appetite, a weakened immune response, diarrhea, and pregnancy difficulties. [24] There has recently been concern that the growth of youngsters may suffer. Children that are stunted (low height for age) usually suffer developmental delays, [13] and a zinc deficiency is one of the causes of this. It is likely that their delayed development is caused in part by a zinc deficit.

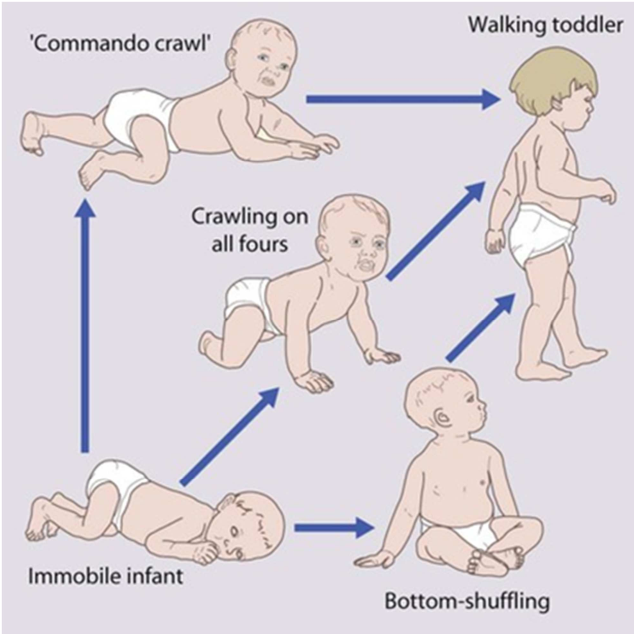

Figure 7. *Nutrition and Health Education.*

4. Current Policies and Intervention Programs

4.1. Infant and Small Child Feeding Programs

The Bangladeshi government, UN agencies, non-governmental organizations, and donors have all supported interventions aimed at improving infant and young child feeding practices from birth, when exclusive breastfeeding is encouraged, to the various stages of complementary food introduction from 6 months and beyond, using a variety of means and methods. These programs are sometimes integrated with others that focus on health, food, livelihoods, water, sanitation, and hygiene.

4.2. Controlling Anemia in Children Aged 6 to 59 Months

To prevent anemia and other micronutrient deficiencies, Bangladesh's National Strategy for the Prevention and Control of Anaemia suggests that children aged 6 to 23 months (and 24 to 59 months if resources are available) use multiple micronutrient powder (MNP) in their diet. The Bangladesh Rural Advancement Committee (BRAC)/Global Alliance for Improved Nutrition (GAIN) is now funding one large-scale area-based MNP program that uses the government-approved five-component (Fe, folic acid, zinc, and vitamins A and C) powder. In 2013, BRAC's community health workers (Shasthya Shebika) visited rural regions and distributed 145 million MNP sachets.

4.3. Dietary Diversity Promotion

Many government and non-government groups in Bangladesh have funded a variety of projects and programs aimed at increasing the diversity and quality of the country's food. The Bangladesh Country Investment Plan is a "roadmap for investment in agriculture, food security, and nutrition," according to its Plan of Action 2008-2015. [11] The Bangladesh Country Investment Plan promotes community-based household gardening, small-scale animal husbandry, aquaculture, and education with the objective of enhancing family food supply and access, especially to micronutrient-rich foods. To optimize the potential of these initiatives to treat micronutrient deficiencies, further targeting, outcome monitoring, and communication interventions would be required. [12] Despite the fact that the National Nutrition Services supports mass media campaigns, social mobilization, and behavior change communication activities at the health facility and community clinic levels, the Ministry of Agriculture and other food-related ministries must also reinforce these specific nutrition-related messages.

4.4. Nutrition and Health Education

Combining community development activities with national programs for decreasing malnutrition with the aim of boosting intake of different foods is one of the best ways to treat micronutrient deficiencies. It is necessary to increase the general public's understanding of the connection between food, nutrition, health, and disease. The nutritional value of agriculture must be increased by teaching farmers about the necessity of producing foods high in micronutrients. In several South Asian countries, the production and consumption of foods high in vitamin A have been increased for more than [20] years by combining home or community gardening with cutting-edge nutrition education and social marketing strategies. [10] Two successful social marketing campaigns that used mass media, [11] one in Indonesia and the other in Thailand, were said to have improved people's knowledge, attitudes, and behaviors. [7] Significantly positive views about vitamin A were found in Indonesia, and after two years, consumption of foods high in vitamin A increased by 10 to 33% of the target group. [17] A pilot social marketing campaign was started in north-east Thailand with the intention of increasing consumption of the ivy gourd and fat, a single meal high in vitamin A. This effort emphasized the need of finding and promoting meals high in -carotene, such as dark green leafy vegetables. Additionally, it encouraged appropriate preservation, storage, marketing, and food preparation techniques to enhance nutrient retention in traditional cooking. [27]

4.5. Enhancing Hygiene

A person's nutritional status and health are determined by proper food digestion, nutrient absorption, and nutrient use inside the body. Utilization requires not just a healthy diet but also a physically healthy environment with access to clean water for drinking, good sanitation and cleanliness, and quick access to medical care in case of illness. In truth, unless major focus is placed on preventing communicable diseases like diarrhea, decreasing morbidity, and improving basic health care facilities, efforts to fight micronutrient deficiencies will mostly fail. Hunger and disease are a vicious cycle that will require special efforts to break.

5. Discussion

The NMS 2011-2012, Bangladesh's most recent national survey, provided crucial information for public health and nutrition planning. Additionally, it has brought with it a variety of technical and operational challenges. There are a lot of concerns that need to be handled, researched, and thoroughly investigated even if the administration is making progress on developing a new strategy. MNP programs for kids aged 6-9 months should be carefully assessed to see if the composition of MNP needs to be altered in light of the vast range of prevalence of Fe deficiency and IDA in the nation based on the most current micronutrient survey. Fourth, the USI program in Bangladesh is a perfect example of a situation where we know exactly what has to be done but the results have been less than ideal despite considerable resources and an apparent strong commitment to execution. Finally, whether to treat vitamin deficiencies in the short, medium, or long term is a topic of discussion in Bangladesh and throughout the world. It will be crucial to keep a careful eye on the condition in the next months and years and make sure that the ideal therapy combination is implemented using evidence-based practices. The need of identifying specific nutrition-related indicators will rise in food-related activities, ensuring that programs first detect, then correct, any dietary shortfalls, whether seasonal or for particular populations (e.g., age or wealth). Initiatives in agriculture and horticulture that improve food quality and diversity must be accompanied with special supplements meant to alleviate nutritional deficiencies in the near term and to fulfill the requirements of vulnerable groups. [11]

6. Conclusion

While many micronutrient deficiencies in Bangladesh have become less severe over the past several decades, a sizeable segment of the population, particularly children and women, still lacks essential micronutrients. The study also showed the effects of adding nutrients that are important for human health, such as vitamins and minerals, to food. Food fortification is a term used to describe a nutritional intervention program with a particular target demographic. The target demographic's willingness to accept, buy, and consume the fortified food influences success. Numerous intervention initiatives are in place to address the issue of micronutrient deficiencies, particularly for Iron and zinc inadequacy. The result of these efforts, however, is by no means acceptable. Nutrient-specific nutrition policies and programs are unlikely to prevent and manage micronutrient deficiencies given the complexity of the factors that contribute to them in Bangladesh and other low-income countries. To guarantee excellent service delivery, precise monitoring, and reporting for improved results regarding the micronutrient status of targeted populations, it is also essential to have adequate resources and collaboration between health and food sector workers. Fortification, bio-fortification, and genome-wide association studies are only a few of the methods used to treat micronutrient deficiencies that have improved the micronutrient content of food in recent years. Some strategies focus on short-term gains, while others are more concerned with long-term challenges. Because of financial restrictions, micronutrient-rich foods are frequently excluded from meals, resulting in the failure of food supplementation programs to address micronutrient deficiency. Long-term strategies include dietary diversification, lowering nutritional losses, increasing nutritional bioavailability, fortification, and bio-fortification. Since they are rarely quantifiable, the outcomes of food-based treatments are notoriously hard to evaluate. Initiatives focused on food that aim to achieve sustainable development have had trouble taking off. Community- and health-focused organizations have ignored these strategies in favor of programs that have yielded quick and noticeable results. Numerous underdeveloped countries, international institutions, and non-governmental organizations (NGOs) have demonstrated that food-based approaches offer a practical and locally viable remedy for micronutrient deficiencies.

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