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# The Burden of Micronutrient Deficiency and the Current Trends of Food Fortification in India

## Review Article

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### Abstract

**Background:** Micronutrient deficiencies (MNDs) affect approximately two billion people worldwide across all age groups and geographical locations. The most common MNDs are vitamin A deficiency, iron deficiency anemia, and iodine deficiency disorders, which affect one-third of the world's population. Food fortification is an important strategy endorsed by the World Health Organization to combat this public health challenge, also referred to as "hidden hunger".

**Scope and Approach:** We describe the burden of micronutrient deficiencies and the current trends and regulations related to food fortification in India.

**Key findings and conclusions:** Prevalence of MND's remains high in India. The Draft Food Safety and Standards (Fortification) Regulation published by the Food Safety and Standards Authority of India in 2016 was a major step towards expanding the practice of and increasing access to fortified foods in India. This regulation recommended fortification of widely consumed staple foods, including rice and wheat flour (Iron, vitamin B12, and folic acid), milk and edible oil (Vitamins A and D), and salt (Iron and iodine). The regulation mandated the use of the food fortification logo (+F) by food manufacturers selling fortified foods. These recommendations are being updated regularly with plans for promoting fortified food both in the open market and in existing government nutrition programmes, most critically in the public distribution systems. Integration of fortified foods into existing public food delivery models provides a cost-effective approach to combating MNDs and ensures we achieve the "Ending hunger" component of the sustainable development goals.

**Keywords:** Food fortification; Hidden hunger; India; Micronutrient deficiency

## Introduction

Micronutrients (MNs) are essential nutrients and include vitamins and minerals. MNs are required in small quantities by the human body for vital functions and for proper growth and development. Micronutrient deficiencies (MNDs) refer to the lack of these vital nutrients. According to estimates from World health organization (WHO), approximately two billion people suffer from MNDs globally. The most common MNDs are vitamin A deficiency, iron deficiency anemia, and iodine deficiency disorders (IDDs), which affect one-third of the world's population and cause a variety of diseases and disabilities. It is estimated that approximately 2 billion people suffer from anemia and IDDs and 254 million preschool children suffer from vitamin A deficiency [1]. MNDs can affect people of all ages and from all parts of the world, including both developing and developed countries. However, in low and middle-income countries, women and children are more vulnerable to developing MNDs [2].

MNDs are also referred to as hidden hunger as it is not caused by a lack of food itself, but due to a lack of quality food rich in nutrients. It affects both undernourished and obese people. The human body cannot produce MNs and, therefore, these must be obtained from food. A diverse diet consisting of green leafy vegetables, dairy products, and fruits is essential to obtain the required quantity of MNs. This is very challenging for people in countries like India, where poverty and food insecurity are rampant. Inequitable access to different types of foods, food insecurity, poverty, and a lack of knowledge about good dietary practices may all be factors that contribute to MNDs. As per a recent report by the Food and Agriculture Organization, India has the highest number of food-insecure people in the world [3].

India has dedicated national programmes to deal with major MNDs including anemia, IDDs and vitamin A deficiency. However, these are focused on specific nutrients and require people to adhere to consuming the supplements, with a focus on the treatment of


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MNDs. A more robust public health approach would be preventative, sustainable, and cost-effective while reaching a wider population. Food fortification of staple foods has long been recommended by the WHO and FAO as a method of combating MNDs [1]. However, it is essential that the process of fortification follows the standards set by WHO and is accessible to the people who most need it.

We describe the burden of MNDs, the history and types of food fortification, and the current regulations and practices related to food fortification in India.

## The burden of micronutrient deficiency in India and its effects

**Vitamin A deficiency:** India has a huge burden of vitamin A deficiency, with the prevalence estimated at 62% of preschool children. Five percent of pregnant women are also estimated to manifest symptoms of subclinical vitamin A deficiency [4]. Vitamin A deficiency leads to Xeropthalmia, which includes a spectrum of visual disturbances ranging from night blindness to Keratomalacia. As part of the vitamin A prophylaxis programme in India, all preschool children in the community receive a single oral dose of 200,000 IU every six months.

However, the coverage remains low. As per the National Family Health Survey – 5 (NFHS-5) data, only 72.2% of children aged 9-35 months reported receiving a vitamin A dose in the last 6 months in Maharashtra state in Western India, which was a drop from the data reported in the previous survey (73.6%). This has varied in different states, with percentages as low as 58%, 56%, and 44% in several states in India (Assam, Bihar, and Lakshadweep respectively) [5].

**Iron deficiency anemia:** India has the highest prevalence of anemia among women in the reproductive age group [6]. According to NHFS-5 data, anemia has worsened in India over the past 5 years, with 68.4% of children and 66.4% of women surveyed suffering from anemia [7]. Anemia in children leads to growth defects, decreased immunity and, in adults, it causes fatigue and decreased work capacity [8,9]. Anemia during pregnancy leads to fetal growth retardation and low birth weight. Blood loss in anemic pregnant women is fatal during childbirth. Even with a dedicated government programme like the National Nutritional Anemia control programme, the burden of anemia among women in the childbearing age group in India remains high.

**Iodine Deficiency disorders:** Iodine deficiency leads to a range of illnesses, including goiter, hypothyroidism, deaf-mutism, mental disorders, and muscular weakness, which are collectively referred to as Iodine deficiency disorders (IDDs). It is also associated with intrauterine defects, miscarriages, and stillbirth [10]. IDDs are the most common preventable cause of mental retardation [11]. The whole population of India is prone to developing IDDs in India as the subcontinental soil is deficient in iodine, which affects the foods grown in the soil and nutrients derived from it [12].

**Folic acid and Vitamin B12 deficiency:** Folic acid and vitamin B12 play important roles in human reproduction and child development. Deficiency has been linked to neural tube defects, megaloblastic anemia, and poor birth outcomes such as stillbirths, abortion, and low birth weight [13-15]. A meta-analysis in 2015 showed a high prevalence of neural tube defects in India [16]. The Indian population, with a largely vegetarian diet, is susceptible to vitamin B12 deficiency. A cross-sectional study found about 47% of the urban population in North India to be vitamin B12 deficient [17].

### Vitamin D deficiency

Vitamin D deficiency is associated with skeletal abnormalities, including rickets and osteomalacia. Research has also shown that it affects immunity, cardiovascular health, and cancer [18,19]. Despite adequate sunlight in a country like India, the prevalence of vitamin D deficiency is estimated to be high, with studies reporting the prevalence of anywhere between 40 to 90% [20].

The prevalence of these MNDs in such huge numbers in India calls for a public health measure that can sustainably reach a huge population, and food fortification of staple foods offers the best solution.

## Food fortification

Food fortification has been defined by the WHO and FAO as "the practice of deliberately increasing the content of an essential micronutrient, i.e. vitamins and minerals (including trace elements) in a food, so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health" [1].

Food fortification is not a new concept. In ancient Persia, iron fillings were added to sweet wine to increase the resistance of sailors to arrows [21]. Fortification of food items began in the 1920s in Switzerland and the United States, where iodine was added to salt to treat endemic goiter and cretinism [22]. Vitamin A and D were added to dairy products, and the addition of iron and folic acid to flour started by 1930s and 40s in Western countries. Currently, with the commercial fortification of foods, a variety of foods are fortified with different micronutrients.

The vehicle and the fortificants are two components of a fortified food. The vehicle is the food to which nutrients are added. The fortificants is the nutrient that is added to the vehicle. For fortification to be effective the vehicle should be consumed as part of a regular diet and the nutrient added should provide adequate nutrition (not toxic for those who are deficient and adequate for those with deficiencies). Examples of vehicles include wheat, rice, milk, dairy products etc.

In 2006, the WHO and FAO published a document titled "Guidelines on food fortification with micronutrients" which provides information on candidate vehicles and fortificants, steps involved in designing, implementing, and sustaining fortification programs, and implementation of monitoring and evaluation systems [1]. Also, the various methods of food fortification were described, including mass fortification, targeted fortification and market-driven fortification. Another method of fortification is household fortification which combines approaches of fortification and supplementation. Examples include micronutrient powders, soluble or crushable tablets and MN-rich spreads [22]. Community level fortification of foods is still at an experimental stage and, for example includes the addition of micronutrient premix to small batches of flour during the milling process [23].



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Biofortification is a novel method of food fortification where plants are genetically modified and bred to improve their nutrient content. But more research is needed to look at the safety and effectiveness of these methods and their impact on the environment.

There are numerous advantages to using food fortification as a method to combat MNDs. There is a potential to reach a large population, without major changes in the dietary patterns of the population. Fortified foods supply MNs in amounts that are not toxic to those who have sufficient nutrients while providing for those with deficiencies, which is as close to natural levels as are found in a well-balanced diet, which is not the case with supplements. Multiple micronutrients can be added to a single food, making it easier to manage MNDs.

However, there are limitations to food fortification as well. They are not meant as a substitute for a well-balanced diet that provides macronutrients in addition to micronutrients. Furthermore, strong distribution systems are required, particularly in developing countries, to reach the poorest segments of society, who suffer the most from MNDs.

### Food fortification in India

Food fortification in India, too, is not a novel concept, with Vanaspati (hydrogenated vegetable oil) having been fortified with vitamin A since the 1950s. The National Goiter Control Programme was launched in India in 1962, in the conventional Goiter Himalayan belt, with the aim of providing iodized salt in place of common salt in goiter endemic regions. Later on, it became evident that IDDs were much more widespread. In 1986, the Government of India launched the IDDs control programme aiming to replace all edible salt with iodized salt and, in 2005, banned the sale of non-iodized salt [24]. The national institute of nutrition in Hyderabad, developed a technology for double fortification of salt with iron and iodine to tackle both the burden of IDDs and iron deficiency anemia.

### The Food Safety and Standards Authority of India (FSSAI) and food fortification

In a landmark decision in 2016, the FSSAI published the Draft Food Safety and Standards (Fortification) Regulation, which changed the landscape of food fortification practices in India [25]. The purpose of this regulation is to introduce guidelines for fortification of staple foods for the Indian population. Guidelines were added for fortification of 5 staple foods, including rice and wheat flour (Iron, folic acid and vitamin B12), milk and edible oil (Vitamins A and D), and salt (Iron and Iodine). These foods were chosen as they are consumed on a large scale. The regulation also introduced the requirement for food manufacturers to label fortified foods using a standard, simple, easily identifiable logo (+F).

The Draft Food Safety and Standards (Fortification) Regulation were again updated in 2018, as the Food Safety and Standards (Fortification of foods) Regulation 2018 [26]. As per the act, fortification of the staples mentioned in the act is not mandatory, but if any food business partner (FBO) wants to fortify these commodities and use the "+F" logo, they should fortify the products as per the standards laid out in the act and have to comply with all the provisions of the act.

The "+F" logo signifies that the particular food is fortified with micronutrients as per the levels specified in the Food Safety and Standards (Fortification of Foods) Regulation 2018. Iodization of salt is mandatory as per the provisions of this regulation.

Furthermore, if the FBO wishes to add nutrients other than those listed in the act, they may do so under the category of 'proprietary food" in quantities not exceeding one RDA for the micronutrient, but they cannot use the "+F" logo or certify their food as fortified. The act provides for a maximum and minimum permitted dosage for the fortification of staple foods. Every fortified food must bear the food fortification logo, as well as the words "fortified with ___ (name of fortificant)" on the package.

The most recent update to the regulations was in December 2020, with compliance by FBO from July 2021. This includes additional recommendations for "fortified processed foods," such as multigrain flour, various types of milk (cow's milk, buffalo milk, full cream milk, toned milk, and so on), and processed cereals, such as noodles, breakfast cereal, and pasta, as well as fruit juices.

The FSSAI published a report in 2018, in which the plan and estimated budget to integrate and promote food fortification in the open market and existing government programmes, including Integrated Child Development Services (ICDS), Mid-day meal (MDM) scheme and Public distribution System (PDS) has been outlined [27]. It is estimated that through integration with ICDS and MDM, approximately 18 crore people would get access to fortified foods, and if extended to PDS, 80 crore people would benefit, with only a small incremental cost to the existing budget of these programs.

## Conclusion

MNDs are a major public health problem. These affect people in both developed and developing countries in huge numbers. It can impact economic development due to its impact on work productivity. Sustainable development goal-2 aims to end hunger [28]. It is also essential to focus on the "hidden hunger" pandemic of MNDs to achieve this goal. Food fortification is a low-cost and scalable solution to tackle the problem of MNDs in India. The recommendations and guidelines set by the FSSAI, show the government's commitment to the long-term fortification of food. Integration of fortified foods with existing Government nutrition programs is a good approach to ensure that these foods are available to the poorer sections of society, who are most vulnerable to MNDs and malnutrition. However, adequate surveillance and monitoring systems will be needed in the future to evaluate the reach and success of these programs.

## Author Contributions

Priyanka Raichur: Conceptualization, Roles/Writing - original draft. Dnyanesh Limaye: Writing - review & editing. Anil Pawar: Supervision, Writing - review & editing.

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