Vitamins and Minerals

Vitamins and minerals, essential for the body are represented by the umbrella term "micronutrients", as they are only needed in tiny quantities as against the "macronutrients" (carbohydrates, proteins and fats). Micronutrients are, however, critical for the production of enzymes, hormones and metabolites that govern growth and development.

Micronutrient malnutrition is a significant public health issue since it afflicts more than 2 billion individuals, or one in three people, globally[1]. Micronutrient deficiencies (MNDs) are referred to as "hidden hunger" because the symptoms of deficiency manifest gradually over time and are apparent only when the deficit becomes severe. However, the consequences of mild or moderate deficiency that are frequently not detected have large health, social and economic impacts on individuals and their communities[2]. The deficiencies of micronutrients often co-exist and contribute to high rates of morbidity and mortality particularly among the vulnerable groups (pregnant women and children under 5 years)[3]. Micronutrient deficiencies have numerous negative consequences across age groups in a continuous intergenerational cycle. Increased micronutrient demands during pregnancy and lactation, if not adequately met, result in sub-optimal nutritional status in children. As these children grow into the reproductive years with the nutritional disadvantage, the cycle of micronutrient deficiencies continues across the life span (Fig 1)[4].

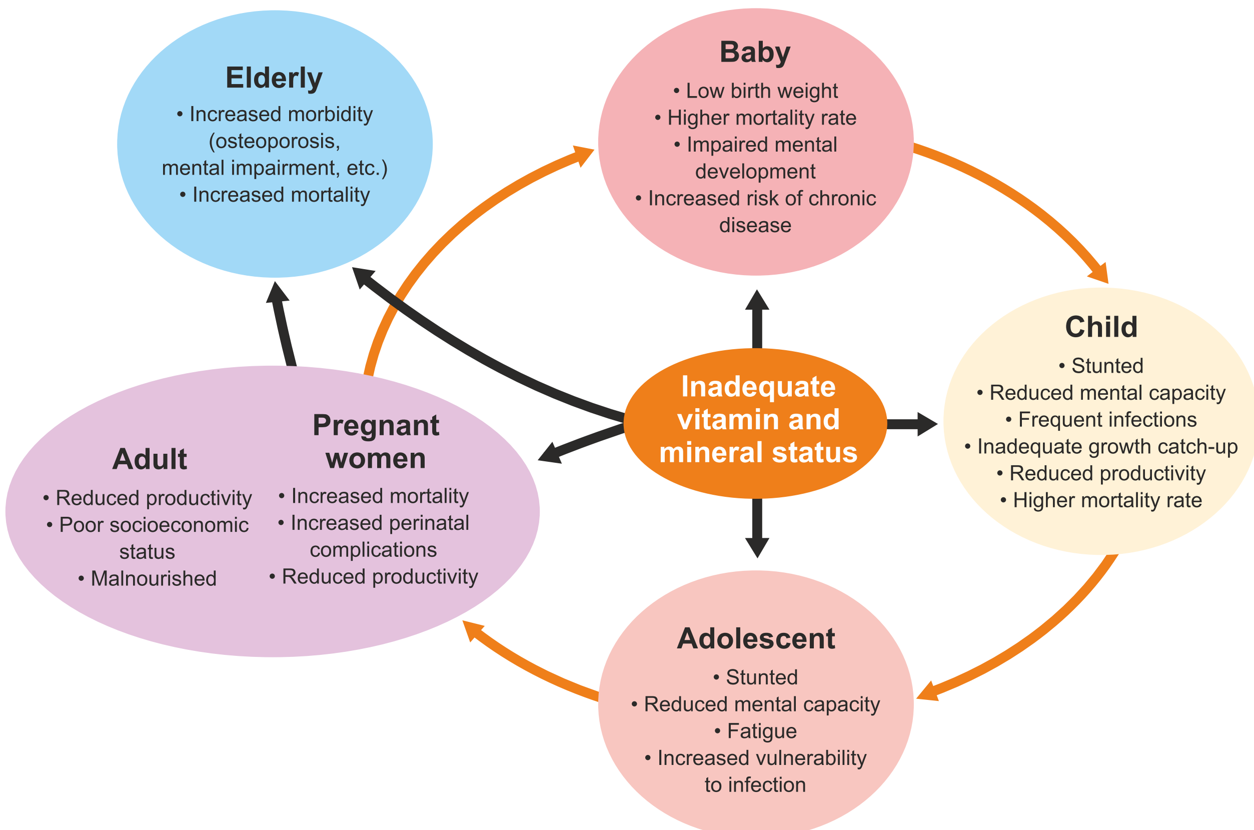

Fig 1- The conceptual framework for the cycle of micronutrient inadequacies across the life span[4]

Adapted from Bailey R, et al. Ann NutrMetab 2015; 66(supp 2):22-33

Most MND disorders can be reversed with provision of missing micronutrients. However, some deficiency disorders result in irreversible, lifelong consequences.

Micronutrient Malnutrition-The Hidden Hunger

Key global statistics:

- More than 2 billion people worldwide suffer from hidden hunger, more than double the number of people who do not have enough calories to eat[1,5].
- The most widespread and documented deficiencies are those of iron, zinc, vitamin A, iodine and folate; deficiencies of vitamin B 12, calcium and vitamin D are increasingly being recognized in recent times[3].
- A large proportion of the burden of hidden hunger is found in the developing world (Africa and South Asia); iron and iodine deficiency, are also widespread in the developed world [1].
- The economic costs of all forms of micronutrient deficiency can be considerable, resulting in a reduction of the GDP (gross domestic product) by 0.7–2 percent in most developing countries[1].

Micronutrient Malnutrition-Indian Scenario

Micronutrient deficiencies are widespread in India. A high prevalence of anaemia (14–88%) and vitamin A, B2, B6, B12, and C deficiencies (44-66%) have been observed even in children of affluent families[6].

Around 50-80% of preschool children, adolescents and pregnant women do not meet even 50% RDA for several key micronutrients[6].

India sustains a 1% loss of GDP on account of micronutrient deficiencies[1].

"The hidden hunger due to micronutrient deficiency may not be felt in the belly but it strikes at the core of one's health and vitality" [1].

Micronutrient Deficiencies of Greatest Concern

Iron:

Iron deficiency is the most common and the most severe of all micronutrient deficiencies in the world that affects more than 30% of the world's population, an estimated 2 billion people[4]. In all age groups (except adult men) barely one-third of the population has a normal haemoglobin level (≥12g/dl)[7].

The mineral iron is an essential component of haemoglobin, myoglobin, enzymes, and cytochromes and is necessary for oxygen transport and cellular respiration. Iron is also critical for optimal growth and cognitive function[4].

The effects of iron deficiency include low energy levels, anaemia, impaired motor and cognitive development, increased risk of maternal mortality, premature births and low birthweight[1].

Vitamin A:

Vitamin A is a fat-soluble vitamin with multiple roles in the body including vision, cellular differentiation, immune function, reproduction, organ and bone formation and growth[4].

The effects of vitamin A deficiency, more common among pregnant women and preschool children, include night blindness, visual impairment, blindness, increased risk of severe illness from common infections such as diarrhoea and increased risk of death[1].

Globally Vitamin A deficiency affects 190 million preschool age children and 19 million pregnant women[1]. Studies show that even when clinical evidence of deficiency is not significant there is a high prevalence of sub-clinical vitamin A deficiency as indicated by lowered blood levels of Vitamin A (serum retinol levels <20 μg/dl)[7].

"Nutrition is the most powerful adaptable environmental factor that can be targeted in order to reduce the burden of disease across an individual's entire life span" [4].

Iodine

Iodine is a trace mineral and approximately 60% of the total body pool of iodine is stored in the thyroid gland. Its primary function is in the synthesis of thyroid hormone which is necessary for the regulation of human growth and development[4].

Globally, around two billion people are estimated to have an inadequate iodine status and approximately 30% (241 million) of the world's school-aged children have insufficient iodine intakes[4].

Universal salt iodization has been the most practical strategy to reduce iodine deficiency. However, largely due to insufficient availability and use of inadequately iodized salt, iodine deficiency has been observed in less than 5% of the population in data emerging from six out of the eight states studied in India[7].

The effects of Iodine deficiency include brain damage in new-borns, reduced mental capacity and goitre[1].

Folate

Folic acid is essential for DNA synthesis. Women of reproductive age, pregnant women, and young children are at the highest risk of deficiency.

Folate deficiency causes megaloblastic or macrocytic anaemia and increases the likelihood of pregnancies associated with neural tube defects. Folate deficiency in pregnancy has also been linked with low birth weight, preterm delivery, and foetal growth retardation[4].

There are large-magnitude deficits in the folate content of diets which can be met only through fortification. For example, folic acid requirements are approximately 8 times more than what normal food provides to pregnant mothers in rural India[7].

Zinc

Zinc is an essential mineral and is involved in multiple aspects of cellular metabolism. Zinc is required for the activity of more than 200 enzymes, and it is critical for normal immune system function, cell division, and protein and DNA synthesis[4]. It may be one of the factors contributing to childhood stunting[2].

Globally, it is estimated that 17.3% of the population has inadequate zinc intakes, with the highest estimates being in Africa (23.9%) and Asia (19.4%)[4].

Emerging Micronutrient Deficiencies (Vitamin D, Calcium, Vitamin B12)

It was widely believed that in tropical environments vitamin D deficiency was unlikely due to the availability of adequate sunlight. However, several studies done in India show that the prevalence of vitamin D deficiency across all age groups ranges from 40 to 90%[7].

Vitamin D and calcium deficiencies cause growth retardation and rickets in children as well as osteoporosis and osteopenia (weak bones) in adults. Furthermore, vitamin D deficiency is associated with an increased risk of common cancers, autoimmune diseases and hypertension[2].

Although the requirements for vitamin B12 are very small, data from several countries indicate a high prevalence of vitamin B12 deficiency. In addition to dietary insufficiency, several commonly used drugs such as antidiabetics may also contribute to a B12 deficient state[7].

Strategy to combat Micronutrient Malnutrition:

Addressing MNDs has been accomplished through supplementation, fortification and various food-based approaches including dietary diversification. Supplementation is a cost-effective solution but does not address the root cause of the MND. Food fortification seems to be an effective means to address MNDs as it enables a larger segment of a population to be targeted[4,8].

> "Micronutrient deficiencies have consequences throughout an individual's life span and are perpetuated across the generations"[4].

Advantages of Food Fortification

- Fortification is the process of adding nutrients or non-nutritive bioactive components to foods in order to correct or prevent nutrient inadequacies, to restore nutrients lost during processing and to balance the total nutrient profile of a diet[9].
- Fortification of foods with added vitamins and minerals has safely and effectively been in use for over a century now and billions of people around the world are consuming foods with some level of added nutrients[5]. Food fortification is a one-window solution to tackle multiple MNDs through a simple intervention[10].
- Fortification aims to supply micronutrients in amounts approximately similar to those provided by a well-balanced diet. Consequently, fortified foods will contain "natural" or "near natural" levels of micronutrients which may not be the case with the intake of supplements[8]. Food fortification can reach wider at-risk population groups through existing food delivery systems without necessitating major changes in existing food consumption patterns, thus resulting in better compliance[10].

Widely Used Fortified Foods

Food/Vehicle	Fortifying agent
Salt	Iodine, iron
Wheat and corn flours, bread, pasta, rice	Vitamin B complex, iron, folic acid, vitamin B12
Milk, margarine, yoghurts, soft cheeses	Vitamins A and D
Sugar, monosodium glutamate, tea	Vitamin A
Infant formulas, cookies	Iron, vitamins B1 and B2, niacin, vitamin K, folic acid, zinc
Vegetable mixtures amino acids, proteins	Vitamins and minerals
Soy milk, orange juice	Calcium
Juices and substitute drink	Vitamin C
Ready-to-eat breakfast cereals	Vitamins and minerals
Diet beverages	Vitamins and minerals

Adapted from: Tulchinsky T.H.,2010[11].

In recognition of the importance of essential nutrients to good health, Kellogg's has been providing breakfast cereals with added vitamins and minerals since, 1940's.

Kellogg's ready-to-eat cereals are fortified with vitamins C, B1, B2, B3, B6, B12 and Folic acid and minerals including iron, calcium and zinc. Minerals like magnesium, zinc and phosphorous also are naturally present in many cereals.

Cereals make a difference in people's diets:

Dietary studies demonstrate that eating breakfast cereals containing vitamins and minerals make a significant contribution to the intake of key essential vitamins and minerals.

- Among Australian adults, breakfast cereal consumers had healthier diets at both breakfast and throughout the rest of the day. They were also most likely to meet the daily recommended serves for grain foods, fruits, dairy and vegetables[12].
- Daily consumption of a micronutrient fortified breakfast cereal with milk for 12 weeks by adolescent girls in UK increased intakes of vitamin B1, B2, B6, B12, folate, iron and

vitamin D. It also elicited significant improvement in biomarker status for vitamin B2, B12, folate and iron[13].

- Barr et al, 2014, demonstrated that among Canadian children and adolescents, the prevalence of nutrition inadequacy for vitamin D, calcium, iron and magnesium was lowest in consumers of RTEC (ready to eat cereal) breakfasts compared with those who skipped breakfasts or ate other types of breakfasts[14].
- Fulgoni V & Buckley R, 2015, found that the prevalence of dietary inadequacy was significantly lower for consumers of fortified RTECs compared with non-fortified RTECs in US population (NHANES 2007-2010)[15].
- In the same population group, nutrient intakes were assessed by substitution modelling in which solid foods eaten at breakfast were replaced with iso-caloric amounts of ready to eat breakfast cereals that were most frequently eaten by different age-race groups. Replacement with RTECs resulted in significantly higher intakes of whole grains, fibre, vitamin D, iron and folic acid and replacement with RTECs along with milk resulted in diets significantly higher in dairy, calcium, potassium and overall diet quality at a lower cost[16].
- Among Malaysian children RTEC contributed 10% and 15% to daily intakes of calcium and iron respectively and ≥20% to daily intakes of vitamin C, thiamine, riboflavin and niacin. RTEC consumers had significantly higher mean intakes of vitamin C, thiamine, riboflavin, niacin, calcium, iron and sugar but lower intakes of fat and sodium than non-RTEC consumers at breakfast and for the total day[17].
- Nutritionists recommend that around 20-25% of the day's requirement of nutrients should be met at breakfast[18]. One bowl of breakfast cereal each day provides up to 20-25% of daily intakes of essential vitamins and minerals thus demonstrating their valuable contribution to an Indian diet.

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