**Historical Perspective**


Nutrition research in India was triggered not by protein calorie malnutrition but by micronutrient deficiencies. Sir Robert McCarrison's initial research was on thiamine deficiency way back in 1918 at Coonoor in South India. Between 1918 and 1921, a host of other deficiencies also received the attention of researchers, and this included iodine deficiency disorders. Animal experiments to create micronutrient deficiencies underwent a change during that period when experimental diets akin to human diets were used to simulate real-life situations. Newer methods for estimation of micronutrients were developed for niacin, carotene and some of the B-vitamins. The clinical unit of NRL was the first to identify the clinical syndrome of 'burning feet' as being due to deficiency of pantothenic acid.

During the 1960s and 1970s extensive research was undertaken to understand vitamin A deficiency, the major cause for nutritional blindness in children. Keratomalacia, which is now a rarity, was very common at that time. Based on preliminary work, a clinical trial was conducted using oral administration of massive doses of vitamin A in 2500 children. Based on this study, the Government of India initiated the massive-dose vitamin A programme for pregnant women and pre-school children. In 1970, the Government of India initiated the National Nutritional Anaemia Prophylaxis Programme. This was followed by intensive research on iron absorption, iron bioavailability in Indian diets, and the possibility of fortifying salt with iron. Micronutrient research in the 1980s revolved around the vitamin A status of pregnant and lactating women. The research showed that supplementation not only improved serum levels of vitamin A, but also the haemoglobin status. Research on the development of double-fortified salt also commenced during this time.

**Current status of micronutrient deficiencies**

Globally, more than 2 billion persons have micronutrient deficiencies, most of them from developing countries. Data from the National Nutrition Monitoring Bureau (NNMB) over the last three decades have consistently shown that more than 70% of pre-school children consume less than 50% of the RDAs for vitamin A, iron, folic acid and riboflavin. Based on diet surveys, the intake of most nutritional anaemias were another major public health problem, which needed urgent attention. Based on their research at the NIN, a study group under Dr. C. Gopalan recommended iron and folic acid supplementation for pregnant women and pre-school children. In 1970, the Government of India initiated the National Nutritional Anaemia Prophylaxis Programme. This was followed by intensive research on iron absorption, iron bioavailability in Indian diets, and the possibility of fortifying salt with iron. Micronutrient research in the 1980s revolved around the vitamin A status of pregnant and lactating women. The research showed that supplementation not only improved serum levels of vitamin A, but also the haemoglobin status. Research on the development of double-fortified salt also commenced during this time.

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micronutrients is well below the RDA\textsuperscript{15}. Iron deficiency appears to be the most severe of all the micronutrient deficiencies with barely one-third of any age group (except adult men) having normal haemoglobin levels ($\geq 12\text{g/dl}$). Based on computed data from NNMB diet surveys of 2001, the iron density in foods is $\sim 7.2\text{ mg/1000kcal}$ while the requirements for pregnant women, lactating women, and pre-school children are 17.5, 12.4, and 9.7 mg/1000 kcal, respectively. These are large-magnitude deficits which can be met only through fortification. Similarly, folic acid requirements are approximately 8 times more than what normal food provides to pregnant mothers in rural settings\textsuperscript{14,19}. The prevalence of anaemia in children under the age of 3 years had not changed in a comparison of the NFHS-2 data of 1998-99 with the NFHS-3 data of 2005-06.

The prevalence of iodine deficiency disorders (goitre) even after universalization of iodized salt was found to be less than 5% in six out of eight states according to NNMB data\textsuperscript{20}. This is largely due to insufficient availability and use of adequately iodized salt.

While we still debate the benefits of the vitamin A prophylaxis programme, the same data showed prevalence of Bitot's spots in children under the age of 5 years to be $\geq 0.5\%$ in six of the eight states surveyed. Surprisingly, there was a higher prevalence of sub-clinical vitamin A deficiency (serum retinol levels <20 $\mu\text{g/dl}$) even when clinical evidence of deficiency was not significant\textsuperscript{16}. The data in the same study also showed that wherever 2 doses of oral vitamin A were administered as per the programme, the serum retinol levels were in the acceptable range in a significantly higher percentage of children. The current RDA recommendation for intake of $\beta$-carotene is higher when compared to that of earlier years, reflecting the subsequent finding that the body's $\beta$-carotene to vitamin A conversion efficiency is approximately 8:1 only\textsuperscript{15}.

Zinc

The Zinc (Zn) status in pregnant women, lactating women, and young children has been researched considerably since the 1980s. Studies showed that, during pregnancy, there is a gradual decrease in serum Zn levels, but that cord blood Zn is normal\textsuperscript{17}. Several other studies also indicated that the prevalence of deficiency in maternal Zn was to the extent of 20–50%, but cord blood Zn levels were always found to be adequate\textsuperscript{18,19}. For the infant, the source of Zn in the early postnatal period is from breast milk; this decreases progressively but is supplemented by the liver stores acquired during the antenatal period\textsuperscript{20,21}. The Zn status of infants from birth to 9 months showed that formula-fed infants have significantly lower Zn levels than breast-fed ones\textsuperscript{21}. The bioavailability of Zn from our predominantly vegetarian diets is low. Zn absorption, like that of iron, also gets inhibited by phytates. Zn fortification of foods is an area that is yet to be explored.

Vitamin D

It was believed that, in the presence of adequate sunshine in tropical environments, vitamin D deficiency was unlikely. However, several studies done in India showed that the prevalence of vitamin D deficiency across all age groups ranged from 40 to 90%\textsuperscript{22-26}. The FAO and the WHO recommend an RDA of 200 IU/day of vitamin D for all age groups except the elderly, for whom 400 IU/day is the recommendation\textsuperscript{27}. The RDA recommendation for Indians currently is 400 IU for all age groups wherever exposure to sunlight is likely to be inadequate\textsuperscript{15}.

Vitamin $B_{12}$

There are not many studies from India on the prevalence or extent of vitamin $B_{12}$ deficiency, since the requirement is only 1 $\mu\text{g}$. However, studies from Pune\textsuperscript{28} and Nepal\textsuperscript{29} have shown the prevalence of $B_{12}$ deficiency to be 47% and 49%, respectively. Data from other countries also indicate a similar high prevalence of $B_{12}$ deficiency\textsuperscript{30}. In addition to dietary insufficiency, several commonly used drugs may also contribute to $B_{12}$ deficiencies. These include proton pump inhibitors (e.g. Omeprazole), H$_2$-receptor inhibitors (e.g. Ranitidine) and oral anti-diabetic drugs (e.g. Metformin)$^{15}$. The RDA for Indians continues to be 1 $\mu\text{g}$/day for all categories except pregnant women and lactating women, for whom 1.2 and 1.5 $\mu\text{g}$/day, respectively, are recommended. Micronutrient deficiencies during pregnancy could have long-term effects on the developing foetus through altered foetal programming. These deficiencies seem to contribute to altered body composition, insulin resistance, and a heightened risk of cardiovascular disease in adult life\textsuperscript{32-34}. Animal studies over multiple generations have also shown that the epigenetic changes arising out of maternal micronutrient deficiencies during the intra-uterine phase may be transmitted across generations\textsuperscript{35}.

Conclusions

The major reasons for the high prevalence of micronutrient deficiencies are:

- inadequate intake of staple food and nutritious foods
- poor bioavailability of minerals and vitamins
- frequent intestinal parasitic infestations
- the fact that commonly consumed foods and beverages have high levels of inhibitors and low levels of enhancers of micronutrient absorption
the significant negative trend in the iron and zinc concentrations in the wheat cultivars. The primitive cultivars of wheat and rice appear to have favourable nutritional characteristics as compared to the currently used high-yielding varieties.

- reduced dietary diversity and increasing consumption of refined and processed foods.

Micronutrient deficiencies are best addressed by food-based approaches through supplementation, fortification, improved maternal nutrition, and improved infant and young child feeding.

“Weekly multiple-micronutrient supplementation programmes are cost-effective options in urban areas with populations with low risk of energy deficiency and high risk of micronutrient deficiencies. Even in those countries where food fortification works, such as Peru and many other countries, fortification alone does not satisfy the physiological needs of small children, pregnant women and the most vulnerable groups.”

- Aaron Lechtig et al. F & N bulletin, Dec 2006

The author is former Director, National Institute of Nutrition, Hyderabad. The write-up is based on the C. Ramachandran Memorial Lecture which he delivered on November 22, 2012.

References


31. NIH Office of Dietary Supplements; Dietary Supplement Fact Sheet; Vitamin B12, 2011.

32. NIH Office of Dietary Supplements; Dietary Supplement Fact Sheet; Vitamin B12, 2011.


