

Health Benefits of Micronutrients and Strategies to Prevent Micronutrient Deficiencies

Vijaya Khader

Former Dean, Faculty of Home Science, Acharya N.G. Ranga Agricultural University, Hyderabad, India
Author Email: vijayakhader@gmail.com

Abstract

In metabolism and tissue performance, micronutrients play a key role. Sufficient amount of intake is required to maintain tissue function and metabolic processes. In those people who are extremely depleted and the possibility for complications, the clinical benefits of micronutrient supplements are more advantageous in health improvement. Zinc and vitamin A supplements have contributed to lowered diarrhoea and pneumonia in children in developing countries. In slightly malnourished children, there are some indications that micronutrient supplements have cognitive influence. In several diseases, there is strong proof of the benefit of micronutrient supplements. A well-balanced diet tends to support most of the micronutrients.

Index Terms

Deficiencies, Foods, Junk, Micronutrients.

INTRODUCTION

Micronutrients are those vitamins and minerals needed in very small amounts that must be supplied by a variety of foods in the diet. Because micronutrient deficiencies result from complex social, economic and political factors. Successful solutions will involve public health and disease control measures, education and communication, community organisations as well as programs related to food and agriculture. Poverty is persistent and widespread. Despite progress on average per capita consumption of food, people in 33 countries still consume less than 2200K cal per day.

The food comprises two primary groups of nutrients namely macronutrients and micronutrients [1]. Macro stands for large and are named because they form the bulk of the food's nutrient such as carbohydrates (glucose, starch, saccharide, monosaccharide, and disaccharide), protein, and fats (monounsaturated, polyunsaturated) [2]. These nutritive substances provide calories to create muscles and tissue. Micronutrients are vital for several body functions and processes. These nutrients include vitamins and minerals and are required in smaller amounts. The four different types of micronutrients are water-soluble, fat-soluble vitamins, micro minerals, and trace minerals [3].

Water-Soluble Vitamins

Vitamins B and C are water-soluble [4]. Vitamin B12 is generally not stored in the body and excess amounts of this vitamin become flushed out in the urine. This ensures that they must be periodically refilled. Its main role is to generate energy and helps to avert cell damage from metabolic stress. Water-soluble vitamins are vital to produce red blood cells. Healthy foods that are rich in water-soluble vitamins include eggs, fish, spinach, citrus fruits, leafy and green vegetables [5].

Fat-Soluble Vitamins

Vitamins that dissolve in fat are known as fat-soluble vitamins. These vitamins are non-water soluble and stored in the liver and fatty tissue. Vitamins A, D, E, and K are fat soluble and very important for vision protection, improve the immune system, blood coagulation, and supply antioxidants to prevent inflammation [6]. Healthy foods that are rich in fat-soluble vitamins include milk, soybeans, leafy and green vegetables.

Microminerals

Microminerals are required for many body functions, such as muscle, bone strength, and blood pressure control [7]. Healthy foods that are rich in microminerals are milk, lentils, fish, banana, leafy, and green vegetables. (Fig 1 & Fig 2)



Figure 1: Nutrient – rich foods for a healthy life



Figure 2: Vital micronutrients for a healthy life

TRACE MINERALS

Trace elements are required in lesser quantities as opposed to microminerals. It is important to feed muscular oxygen, facilitating efficient functioning of the nervous system, healing wounds, and protecting cells from stress damage [8]. Copper, zinc, iron, and manganese are some of the trace elements that are crucial for many physiological processes [9]. Healthy foods that are rich in trace elements include ostriches, cabbage, pecans, legumes, and cashew nut. In the metabolism and perpetuation of tissue functions, micronutrients play a pivotal role [10]. Sufficient consumption is therefore essential but providing people who do not require them with excess supplements can also be harmful. Comparatively, it is easy to diagnose and treat individual states of micronutrient deficiency.

Biochemical Functions

In improving health and preventing or treating diseases, there is an increased interest in the role of micronutrients. Trace elements also include modulation of the enzyme or form an integral part of prothesis groups of the enzyme. Zinc for example is a cofactor of more than a hundred enzymes, while selenium is essential in selenocysteine form for glutathione peroxidase.

[11]. Various vitamins like niacin and riboflavin are vital and perform effectively in complex biochemical reactions such as electron transport chain [12]. Folic acid plays an active part in the transmission of methyl group [13]. These reactions are essential for intermediate metabolism and provide energy, protein, and nuclear acid for the use of the main nutrients. Zinc performs as a transcriptional control factor and receptors for other hormones. The identification of numerous micronutrients with antioxidant properties is the key cause of the widespread interest in micronutrients [14]. Oxidative metabolism contributes to the production of reactive oxygen species which may cause more oxidative reactions, to a relatively decreased state of cell parts including cell membranes and nucleic acids. The possible harm is restricted by mechanisms such as direct inhibition by a vitamin known as tocopherol (Vit-E) or carotenoids (vit-A) [15]. Some enzyme systems also contribute to the direct quenching effect. These enzymes will inhibit the generation of oxidation-superoxide dismutase and glutathione peroxidase. They were either zinc, copper, manganese, and selenium dependant, respectively.

Some population groups are considered to have low or insufficient consumption of micronutrients. Young children and adolescents may have insufficient consumption of milk and other calcium and elderly individuals have low vitamin D intakes. Also, while the most micronutrients in food available, there is a need for most micronutrients, involving zinc, magnesium, copper, iron, vitamin C, and riboflavin (Fig 3). Reduced levels will lead to a high prevalence of biochemical deficiency [16].

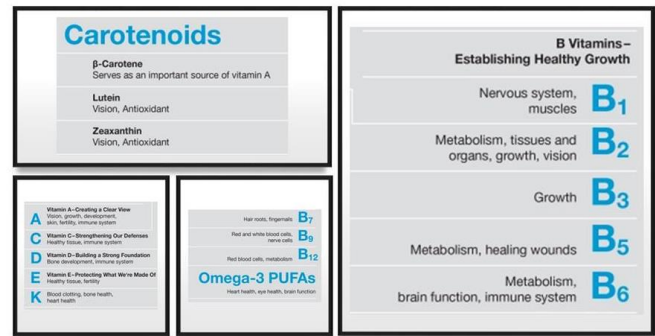


Figure 3: Major sources of Micronutrients

MICRONUTRIENT DEFICIENCY

Micronutrient deficiencies in human health by Kennedy & co-workers (16 A) employ the the term hidden hunger because it occurs when food supplies are meagrely adequate and symptoms of these deficiency often go unrecognised. The most recent estimates of FAO indicate that 840 million people do not receive enough energy from their foods and among the above 799 million people live in developing countries. The global toll of people affected by micronutrient deficiency is estimated to be more than 2 billion.

Disease such as chronic inflammation, acute infection, or neoplastic complications, can lead to anorexia in children. In institutionalized elderly people, these infections are highly probable because of micronutrient deficiency [17]. Reduced protein consumption will lower the micronutrient intake. Persistent mismanagement of alcohol leads to extreme malnutrition through the insufficient intake of several micronutrients. A thiamine deficiency leading to Encephalopathy is well known. Patients are vulnerable to acute vitamin deficiency and result in hypophosphatemia, potassium deficiency (hypokalaemia), and fluid overload complications. The acute infection, operations, and trauma-related infections contribute to increased energy consumption and the degradation of the net protein. The demands for water-soluble vitamins as coenzymes for the metabolic pathways and different trace elements will be increased. During the cell breakdown some intra-cellular elements, including zinc, are released, so that improved levels may not be necessary at this time [18]. Global prevalence of hidden hunger, 19 vitamins & minerals are considered to be essential for physical and mental development, immune system functioning and various metabolic processes.

Vitamins and trace elements supplements have long been thought to enhance facets of cognitive function and several studies indicate that the concentration potential has been enhanced with these supplements. A major study involving residential students in India found that fourteen months of appropriate vitamin and trace elements supplementation resulted in a substantial increase in concentration, but not in IQ, memory, or achievement results [19]. A 14-week low selenium diet has had a major negative impact on the mood score profile. Major changes were seen in a six-month study

period of a supplement that provided energy and micronutrients [20]. Women at the postmenopausal phase are at an increased risk of osteoporosis. While osteoporosis is not the result of paucity of vitamin D and calcium levels, sufficient delivery of these micronutrients is advantageous in sustaining and certainly improving bone mineral density [21]. In the pre-menopausal phase, there is a strong association between zinc consumption and bone mineral density (BMD). In a randomized trial, no losses in BMD in the group supplemented with copper micronutrient were observed than with a substantial reduction in the control group BMD scores [22]. A small study in postmenopausal women of calcium, zinc, manganese, potassium, and copper supplementation showed beneficial impacts on vertebral BMD [23]. Moreover, there is mounting evidence that the bone proteins carboxylation and calcium complexation need an adequate consumption of vitamin K to boost bone weight. There is also a lack of detailed evidence for maximizing dietary intake, and the best recommendations available to ensure a high-fruit and vegetable diet to make sure that both vitamins and trace elements have sufficient intake awaiting future testing.

Macronutrients provide energy and vital material to make sure the whole-body composition. This uninterrupted construction and reconstruction process involves micronutrients. Therefore, depending on the individual requirements related to various metabolic processes in the life cycle, the demand for micronutrients will vary. The micronutrients requisite is high and with an inadequate supply, physical and cognitive growth may be impaired. A paucity in the micronutrients may have severe health implications such as scurvy, rickets, and anaemia [24]. Vitamin D insufficiency in adults contributes to excruciating demineralization of the bones and spontaneous fractures. Subtle pain sensations typically are not diagnosed as vitamin D deficiencies until demineralization becomes apparent. Fibromyalgia, a chronic rheumatic condition is also diagnosed with muscle fatigue and prolonged pain. Recently, a meta-analysis has reported a close link between hypovitaminosis D and prolonged widespread pain. Vitamin D therapy has reduced pain and enhanced living efficiency [25].

Iron is one of the essential micronutrients. Iron insufficiency and shortcomings are present not only in teenagers but also observed among children in high and low-income countries. The anaemia rates of young people vary from 20% to 40%, due to iron insufficiency [26]. Moderate and extreme iodine insufficiency exists in Europe and Africa. While salt is enhanced with iodine, a rising number of iodine defective people appear to be occurring and the results were evident with the NVS-II data. Teens and young adults, particularly women, do not get enough iodine, even not with enriched salt, based on the suggestions for reducing salt consumption. Insufficiency of vitamin D is evolving globally and is a matter of great problem. In high-income countries, vitamin D deficiency diseases are

apparent and even a moderate insufficiency could have a major effect on overall health, especially in pregnancy and aging individuals [27]. The finding of 25(OH)D and not 1,25(OH)2D plasma concentration indicates a strong connection between plasma levels. The incidence of vitamin D deficiency is high in the European countries with a reported rate of 15% and 81% of Saudi Arabian females are reported with Vitamin D deficiency. The global prevalence of insufficiency ranges between 30% and 40% [28]. Even the regulation of dairy products would not guarantee adequacy in many developed countries. Folate is one of the essential vitamins and its supply relies on its sources of bioavailability. NVS-II data indicate that there is insufficient availability, nearly 60% of females and 70% of males with folate deficiency [29].

STRATEGIES TO ADDRESS MICRONUTRIENT MALNUTRITION:

- Dietary diversification
- Fortification strategies
- Food based approaches
- Supplementation
- Community-based strategies to improve micronutrient status
- Encouraging exclusive breast feeding up to six months of age continued breastfeeding for older infants.
- Identifying and promoting use of culturally appropriate weaning foods rich in micro nutrients
- Identifying and promoting use of traditional green leafy vegetables and fruits to add diversity to the diet
- Preserving micronutrients in fruits and vegetables by using solar drying or canning technologies
- Promoting small-scale community gardens
- Rearing small livestock
- Improving year-round supply of micro nutrient rich foods
- Holistic approaches – using mixtures of direct and indirect interventions and public health measures education and awareness campaigns government and government counter parts political commitment and training.

CONCLUSION

Micronutrients are important elements and contribute towards growth and advancement. The roles and effects of micronutrients can vary in the life cycle and must be confirmed by an appropriate diet. However, according to several studies and meta-analyses, various micronutrients are not sufficiently supported during the life cycle. The trends in lifestyles that favour a diet without meat or meat products will contribute to the growth of people with inadequate micronutrients. A mixed diet with adequate energy should be sufficient to ensure a sufficient supply of critical micronutrients.

The food based approach, fortification approach and clinical approach and clinical approach for acute cases have all to be rightly weighed and implemented at pivotal points in

the system depending upon the regional scenario in India to overcome micro nutrient deficiency.

REFERENCES

- [1] Evans P, Halliwell B. Micronutrients: oxidant/antioxidant status. *Br J Nutr* 2001;85(suppl 2):S67–S74.
- [2] Food and Nutrition Board IOM Dietary reference intakes for thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, pantothenic acid, biotin, and choline. Washington, DC: National Academy Press, 1998.
- [3] Food and Nutrition Board IOM Dietary reference intakes for vitamin C, vitamin E, selenium, and carotenoids. Washington, DC: National Academy Press, 2000.
- [4] Hoare J, Henderson L, Bates C J *et al* The national diet and nutrition survey: adults aged 19–64. London: The Stationery Office, 2004.
- [5] Rayman M P. The argument for increasing selenium intake. *Proc Nutr Soc* 2002;61:203–215.
- [6] Clark L C, Combs G F, Jr, Turnbull B W *et al* Effects of selenium supplementation for cancer prevention in patients with carcinoma of the skin. A randomized controlled trial. Nutritional Prevention of Cancer Study Group. *JAMA* 1996;276:1957–1963.
- [7] Weaver C. Adolescence: the period of dramatic bone growth. *Endocrine* 2002;17:43–48.
- [8] Shenkin A. Adult micronutrient requirements. In: Payne-James J, Grimble G, Silk D, eds. Artificial nutrition support in clinical practice. London: GMM, 2001:193–212.
- [9] Cuthbertson D P, Fell G S, Smith C *et al* Metabolism after injury. 1. Effects of severity, nutrition, and environmental temperature on protein, potassium, zinc and creatine. *Br J Surg* 1972;59:926–931.
- [10] Schnyder G, Rouvinez G. Total plasma homocysteine and restenosis after percutaneous coronary angioplasty: current evidence. *Ann Med* 2003;35:156–163.
- [11] Loscalzo J. Homocysteine trials—clear outcomes for complex reasons. *N Engl J Med* 2006;354:1629–1632.
- [12] Heart Protection Study Collaborative Group MRC/BHF heart protection study of antioxidant vitamin supplementation in 20,536 high-risk individuals: a randomised placebo-controlled trial. *Lancet* 2002;360:23–33.
- [13] Miller ER III, Pastor-Barriuso R, Dalal D *et al* Meta-analysis: high-dosage vitamin E supplementation may increase all-cause mortality. *Ann Intern Med* 2005;142:37–46.
- [14] National family Health Survey (NFHS II) 1998–99. International Institute for Population Sciences, Mumbai 2000: 266–274.
- [15] Enriching Lives. Overcoming Vitamin and Mineral Malnutrition in Developing Countries. World Bank Publication, Washington DC 1994; 6–13.
- [16] Vijayraghavan K, Balakrishna N, Antony G M. Report on Food and Nutrient Intakes of Individuals. National Nutrition Monitoring Bureau. National Institute of Nutrition, Hyderabad 2000.
- [17] [16 A] A. Kennedy G.G. Nanlet and P. Shetty. The scourge of Hidden hunger ‘s global dimensions of micronutrient deficiencies, *Food, Nutrition and Agriculture* ,2003 , 32-pp8
- [18] Gershwin ME, Beach RS, Hurley LS. The potential impact of nutritional factors on immunological responsiveness. *In Nutrition and Immunity*. Academic Press, 1985; p 1–7.
- [19] Hambidge KM. Zinc deficiency in young children (Editorial). *Am J Clin Nutr* 1997; 65:160–161.
- [20] Kretchmer N, Beard JL, Carlson S. The role of nutrition in development of normal cognition. *Am J Clin Nutr* 1996; 63:997S-1001 S.
- [21] Guesry P. The role of nutrition in brain development. *Prev Med* 1998; 27:189–194.
- [22] Wainwright P. Nutrition and behaviour: The role of n-3 fatty acids in cognitive functions. *Brit J Nutr* 2000; 83/4:337–339.
- [23] Ogden C L, Kuczmarski RJ, Flegal KM, Mei Z, Guo S *et al*. Center for Disease Control and Prevention 2000 Growth Charts for the United States: Improvements to the 1977 National Center for Health Statistics Version. *Pediatrics* 2002; 109:45–60.
- [24] Allen L, Gillespie S. What works? A Review of the Efficacy and Effectiveness of Nutrition Interventions. United Nations Administrative Committee on Nutrition, Asian Development Bank, September 2001, pp 23–41.
- [25] Cuthbertson D.P. Trace elements—a gap in nature. *Agric Rev.* 1955; 1: 43–50.
- [26] Shenkin A. and Wretling A. Parenteral nutrition. *World Rev Nutr Diet.* 1978; 2: 81–111.
- [27] Anderson GJ, Frazer DM, McLaren GD 2009. Iron absorption and metabolism. *Curr Opin Gastroenterol* 25: 129–135.
- [28] Holick MF, Chen TC. Vitamin D deficiency: a worldwide problem with health consequences. *Am. J. Clin. Nutr.* 2008;87(4):1080S–1086S.
- [29] Mithal A, Wahl DA, Bonjour JP, Burckhardt P, Dawson-Hughes B, Eisman JA, El-Hajj Fuleihan G, Josse RG, Lips P, Morales-Torres J. IOF Committee of Scientific Advisors (CSA) Nutrition Working Group, Global vitamin D status and determinants of hypovitaminosis D. *Osteoporos. Int.* 2009;20(11):1807–1820.
- [30] Symposia, Conferences, Oral communications: 10th International Conference on Frailty, Sarcopenia Research and Geroscience (ICFSR), March 11-13, 2020, Toulouse - France. (2020). *The Journal of frailty & aging*, 9(S1), S1–S45.