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Nutritional Deficiencies-Evaluating the Perception of Health and Nutrition Behavior to Improve Risk Communications

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Abstract

Nutritional Deficiencies refer to an inadequate supply of essential nutrients within the diet which ends up in malnutrition or disease. Nutritional inadequacies can cause a wide range of health problems, like problems of digestion, skin problems, stunted or defective bone growth, and even dementia. Nutritional deficiencies are caused when body cannot absorb and process the nutrients once they are eaten. Most of the nutrient deficiency diseases are caused by lack of protein, vitamins, minerals, carbohydrates and fats. These 5 groups contain 50 nutritional items which are important for health and growth. Malnutrition is one among the many diseases responsible for early death. This can result from anorexia nervosa also. Under-nutrition results in depletion of energy in the body. Many diseases like Kwashiorkor, Marasmus, Xerophthalmia, Nutritional anemia, Endemic Goiter are associated with nutritional deficiency. Inadequate intake of food and infection such as diarrhea, measles, intestinal worms and respiratory infections may primarily lead to malnutrition. This study aims to highlight the different types of nutritional deficiencies and complications associated with them, their prevention and treatment and to identify potential interventions such as reduction of post- harvest losses, increased availability of animal -based products and increasing the productivity which could make a significant contribution in encountering the nutritional hunger in the Indian Sub-continent.

Keywords: Deficiency, Nutrition, Micronutrient, Macronutrient, Anemia, Folate, Iron, Vitamin A, Vitamin B12

Introduction

Poor intake of nutrition, chronic or acute health conditions, altered nutrient metabolism, medication, or a combination of these factors, can directly affect the levels of macronutrients as well as the micronutrients in the body. As a result, this could lead to alterations in energy metabolism, cognitive function, immune response, bone formation, and muscle function, as well as growth and development if the deficiency is present during fetal development and early childhood.

As per the estimates of The Centres for Disease Control and Prevention (CDC), less than 10 % of the United States population has nutrient deficiencies. Further, according to Food and Agriculture Organization report

on state of food security and nutrition in the world, it is estimated that 14.5% of Indian population is undernourished. However, nutrient deficiencies depend upon age, gender, and/or race and ethnicity [1]

Nutrient inadequacy or nutrient deficiencies among the general populations greatly determined by intake patterns of the individuals. Intake of nutrients that are routinely below the Dietary Reference Intake (DRI) can lead to a decrease in how much of the nutrient is stored in the body and how much is available for biological functions [2]. DRIs are based on age and sex and include Recommended Dietary Allowance (RDA), Adequate Intake (AI), Estimated Average Requirement (EAR) and Tolerable Upper Intake Level (UL).

Nutritional deficiencies are classified into two broad categories namely, Macronutrient and Micronutrient deficiencies.

Macronutrient deficiencies

include deficiencies related to protein, fat and/or calories and can result in stunted growth, marked wasting (Marasmus) or a disproportionately large abdomen as in the case of Kwashiorkar. Prolonged inadequate intake of proteins, carbohydrates and fat caused a disease of severe wasting called Marasmus. Prolonged inadequate intake of proteins results in Kwashiorkar. However, essential fatty acid deficiencies, such as Omega-3 fatty acid deficiency, are believed to be rare among the general population [3,4]. The essential fatty acid deficiency signs include a dry scaly rash, reduced growth in infants and children, weakened response and impaired wound healing [3].

2. Micronutrient deficiencies

Micronutrients are the vitamins and the minerals which are consumed in small quantities, but are essential in physical and mental development. Essential micronutrients include, but are not limited to: iron, zinc, calcium, iodine, vitamin A, B vitamins, vitamin C.

Micronutrient deficiencies pose a serious global health issues affecting key development outcomes which include poor mental and physical development in infants and children, vulnerability to diseases, mental retardation, blindness and reduced productivity and potential [5]. The World Health Organization (WHO) estimate that more than two billion people suffer from micronutrient inadequacy globally.

The present review aims at compiling the worldwide trends in key micronutrient deficiencies, their impact on health and development and interventions to address these insufficiencies.

Who is most vulnerable to micronutrient deficiency?

Though any individual can experience micronutrient deficiency, yet pregnant women and children are at a high risk of developing these inadequacies. There is often an increased demand for specific vitamins and minerals during childhood and pregnancy. Nutritional status of a pregnant woman is not only relevant for her own health, but also is a key factor for the consequent growth of her developing child. Therefore, addressing and monitoring the micronutrient deficiencies in the pregnant women and early childhood years is imperative for optimal health and development of a given population.

Anemia (Iron, Folate or Vitamin B12 deficiency)

Iron: Iron is a component of hemoglobin and therefore important in the transfer of oxygen from the lungs to the organs, and is involved in the synthesis of hormones as well as normal growth and development. Deficiency of iron results in micro lytic, hypochromic anemia, impaired cognitive function, weak body temperature regulation, depressed immune function, and spoon like shape of the nails [6].

Folate: Folate is involved in the synthesis of RNA and DNA and is required for cell-division and perversion of Neural Tube Defects. Deficiency causes Megaloblastic anemia and Pancytopenia. In addition it can cause glossitis, angular stomatitis, and oral ulcers [23]. Neuro-psychiatric manifestations, including depression, irritability, insomnia, cognitive decline, fatigue, and psychosis, are also known to occur due to folic acid deficiency [24-27].

Vitamin B12: vitamin B12 participates in red blood cell formation, neurological function and DNA synthesis. Megaloblastic anemia, fatigue, weakness, constipation, loss of weight and appetite [7] are the complications associated with its deficiency. The WHO estimates that 20% of maternal deaths are attributed to anemia alone globally [8] and 40% of pregnant women are anemic [5]. The prevalence of anemic pregnant women is typically lower in high-income regions (North America, Europe and Central Asia). Whereas in South Asia and Sub-Saharan Africa, the prevalence is markedly high, even up to 60% in some countries.

In the children under the age of 5 years, globally, around 42% have anemia. The rates are high across South Asia and Sub – Saharan Africa, with 55% and 60% of children being anemic.

Vitamin A: Vitamin A plays a key role in immune function, vision, cell growth and cell communication. This vitamin is naturally available in two dominant forms: Retinol and Carotinoids. Retinol or vitamin A1 is acquired from animal-based food sources and is extremely beneficial in treating and preventing Xerophthalmia associated with the drying of the cornea. Carotinoids, on the other hand, are generally found in plant-based food sources.

Deficiency of vitamin A results in night blindness and Xerophthalmia, also called dry eye syndrome. The first clinical manifestation of Xerophthalmia that can be assessed is night blindness, a condition in which one cannot see in low light conditions [9]. The reports from the WHO estimates the global prevalence of gestational night blindness in populations at risk of vitamin A deficiency at 7.8% (9.75 million pregnant women); and prevalence rates ≥ 5% are considered of public health concern [10].

About 250 million pre-school children are at risk of Vitamin A deficiency, mainly in developing countries due to insufficiently varied diets, poor maternal education and inadequate hygiene [11]. Moreover, almost half of the children affected globally are found in Africa [10] and Vitamin A deficiency alone is responsible for almost 6% of child deaths under the age of 5 years in Africa [12].

The table below provides information regarding some more specific nutrients, along with their function and source that are of concern in addition to the ones discussed above. However, additional nutritional deficiency disease may occur in population.

Nutrient	Function	Source
Vitamin B6 (Pyridoxine)	Benefits the central nervous system and metabolism. Its role includes turning food into energy and helping create neurotransmitters such as serotonin and dopamine. Also aids in hemoglobin production	Chickpeas, potatoes, onion, spinach, watermelon, banana, tofu, raisins, nuts, cottage cheese, rice, chicken breast, salmon fish, and fortified foods such as breakfast cereals

Vitamin C	Provides protection against immune system deficiencies, cardiovascular disease, prenatal health problems, eye disease and even skin wrinkling. Additionally, it is also vital for collagen synthesis, connective tissues, bones, teeth and small blood vessels.	Plums, cherries, Guavas, cantaloupe, kiwi fruit, lychee, papaya, strawberry, orange, lemon, green pepper, sweet yellow pepper, spinach, mustard and kale.
Vitamin D	Essential for maintaining healthy bones and teeth. It also plays many other important roles in the body including regulating inflammation and immune function	Sunlight, fatty fish such as Salmon and Tuna, egg yolks, cheese, mushrooms, vitamin D supplements, fortified milk, fortified cereals and juices.
Calcium	Involved in muscle function, nerve transmission, and proper bone formation.	Calcium rich foods include yogurt, milk, fortified dairy alternatives such as soy milk, cheese tofu, green leafy vegetables namely broccoli, turnip leaves, kale, many fortified breakfast cereals, fortified fruit juices, nuts and seed especially almonds, sesame and chia seeds, legumes and grains.
Iodine	It is an important component of thyroid hormones that regulate protein synthesis, metabolism, and enzyme activity.	It is mainly found in animal protein foods and sea vegetables, seaweed, fish, iodized table salt, dairy, eggs, chicken, and fortified infant formula. To a lesser extent in fortified foods like breads, cereals and milk
Magnesium	Involved in more than 300 enzyme reactions, protein synthesis, muscle function, blood sugar control, and blood pressure control.	Avocados, bananas, nuts (cashews and almonds), legumes, tofu, pumpkin, chia seeds, flaxseeds, whole grains, fatty fish such as Salmon, leafy greens and dark chocolate
Zinc	Involved in cell metabolism, enzyme activity, immune function, protein synthesis, wound healing, DNA synthesis, and cell division.	Chickpea, cashews, pumpkin seeds, legumes, whole grain, yogurt, dairy products, lentils, bean, spinach, oats, poultry, meat, lobster, avocado, pomegranate, guava, apricot, peach, kiwi fruit and blueberries.

Prevention and treatment of micronutrient deficiency

Vitamin A Supplementation

Vitamin A supplementation was found effective in the reduction of morbidity and mortality [13,14]. In addition to night blindness and Xerophthalmia, Vitamin A supplementation also reduced the severity and fatality from measles and diarrhea. A study conducted in Africa, among pre-school children, found that Vitamin A

supplementation significantly reduced the prevalence of Bitot's spot (1%), fever (15.6%), diarrhea (12%), oedema (6%), measles (7.8%), and conjunctivitis (7.2%). Moreover, children retinol concentration was also improved [15].

Diarrhea treatment in children

In 2015, approximately half a million children died from diarrheal diseases. Diarrhea is considered to be third largest cause of child mortality. Malnutrition in children has direct relationship with diarrhea. Malnutrition can serve to accelerate the risk of mortality from diarrhea. Not only this, diarrhea is also known to affect the ability of children to retain and utilize the nutrients properly. Thus treating diarrhea is therefore a nutritional as well as general health issue. According to the UNICEF consensus- the share of children under the age of 5 who received diarrheal treatment in the form of Oral Rehydration Salts (ORS packets or fluids) was 20 – 30% in India [5].

Anemia prevention and treatment

Iron recommendation during pregnancy (27 mg/day) far exceeds those for non-pregnant, non-lactating women (18mg/day) [16]. Further, because fetal iron requirements take precedence over maternal needs and storage [17], adequate iron intake is important to both mother and fetus. Furthermore, iron requirements of infants under the age of 6 months are generally not well defined, because needs are difficult to estimate in the context of exclusive breast feeding [18]. In addition, during the first 4-6 months of age, most infants benefit from the iron stores present at birth which are accumulated during the last 10 weeks of gestation [19,20]. Hence, for this reason, iron supplementation is typically not recommended for breast fed term infants below the age of 6 months [21]. However, pre-term infants and low birth weight infants are borne with lower birth iron stores, supplementation in the range of 2-4 mg/day is advised in order to avoid iron deficiency [21,22]. For older infants, over 6 months of age, different methods lead to different estimates of daily requirements, with a commonly used factorial approach leading to a recommendation of 11mg/day for 7-12 months old and 7 mg/day for 1–3-year-olds [21].

Folic Acid treatment

Typically, oral folic acid (1-5 mg daily) suffices to treat folate deficiency [28]. Folic acid supplementation at a dose of 1 mg daily is usually sufficient to prevent folic acid deficiency in certain high risk patient populations (bariatric surgery, malnutrition, chronic alcohol use, chronic hemolytic anemia, and conditions with high cell turnover. Women of child bearing age are strongly recommended to ear folate rich foods and receive at least 0.4 mg/day of supplemental folic acid to prevent pregnancy related complications and fetal abnormalities including neural tube defects [29]

Vitamin B12 deficiency treatment

Vitamin B12 deficiency can be treated with intramuscular injections of cyanocobalamin or oral Vitamin B12 therapy. Approximately 10% of the standard injectable dose of 1 mg is absorbed, which allows for rapid replacement in patients with severe deficiency or severe neurologic symptoms [30]. In general, patients with an irreversible cause should be treated indefinitely, whereas, those with reversible cause should be treated until the deficiency is corrected and symptoms resolve. If Vitamin B12 deficiency co-exists with folate deficiency, Vitamin B12 should be replaced first to prevent sub-acute combined degeneration of the spinal cord [31]. Patients older than 50 years may not be able to adequately absorb dietary Vitamin B12 and should consume food fortified with Vitamin B12. the

average intake of Vitamin B12 in the U.S. is 3.4 mcg/day, and the recommended dietary allowance is 2.4 mcg/day for adult men and women and 2.6 mcg/day for pregnant women [32].

Conclusion

On a larger scale, nutritional deficiencies contribute to the global burden of disease, economic costs, and constrained national development. Addressing the nutrient inadequacies requires identifying those at risk and then working to prevent and manage that risk. Dietary improvement, increased production and consumption of micronutrient rich foods, food fortification, supplementation, and global public health and other disease control measures can be implemented to overcome micronutrient malnutrition. Food based strategies, which include food production, dietary diversification and food fortification, are the most sustainable approaches to increasing the micronutrient status of populations. Policies to build and promote alliances among government, consumer groups, the food industry and other relevant organizations could help achieving the shared goal of preventing micronutrient malnutrition. Keeping in view the relationship of nutrient deficiencies with disease and poor living conditions, measures such as reducing disease incidences, better complimentary feeding, improving breast feeding rates, increased immunization coverage, improved water and sanitation conditions, improved antenatal and obstetric care need to be implemented.

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