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Harmful effects of malnutrition and possible sustainable solution

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ABSTRACT

Malnutrition is a condition that results from eating a diet that does not supply a healthy amount of one or more nutrients. It is a condition characterized by lack of one or more essential nutrients from the diet or a surplus of some nutrients which affect the body negatively. Malnutrition consists of two types: undernutrition and overnutrition. Undernutrition involves the deficiency of macronutrients like protein or calories and micronutrients like iron, iodine and many more. Protein energy malnutrition is caused by the inadequate intake of protein and calories. It is further classified in three types, kwashiorkor, marasmus and marasmic kwashiorkor. Malnutrition mainly affects an individual's immune system, lean body mass, cardio-respiratory functions, muscle functions. Malnutrition can be caused due to many factors including unavailability of food, poverty, higher food prices and many more. Strategies like biofortification and supplementation are used for the treatment of malnutrition.

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1. Introduction

Malnutrition¹⁻²⁰ may be defined as a condition of nutrition in which there is either a deficiency or excess of nutrients from one's diet. The nutrients involved in the condition may be energy, protein and macronutrients and their deficiency or excess may cause adverse effects on an individual's body shape, size or composition as well as the mental status. Malnutrition can be termed in two categories undernutrition and overnutrition. If the daily dietary intake of an individual lacks in the essential nutrients or the nutrients are present in low quantity now fulfilling the recommended intake threshold then it is termed as undernutrition. While as if the daily intake of a person has surplus of either calories or other macronutrients, it is termed as overnutrition. When there is undernutrition it may include conditions like stunting,

wasting and underweight while in case of overnutrition it includes overweight and obesity. Wasting may be defined as a condition in which a person has small mid-upper arm circumference and low weight for height and stunting is defined as a condition with individual with low height for age. Extreme undernutrition is characterized by starvation, chronic hunger, SAM (severe acute malnutrition) or MAM (moderate acute malnutrition) with symptoms of a short height, a thin body with very poor energy levels, swollen legs and fluid accumulation by the body tissues, mainly present in abdomen called edema.

Undernutrition can be classified into further two types, protein energy malnutrition (PEM) and micronutrient deficiencies. Protein energy malnutrition is defined as a malnutrition which arises from the continuous lack of protein and energy in terms of calories from an individual's diet. In case of children if the measurements of normal weight for age, height for age and weight for height, fall

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Fig. 1: Malnutrition

below 2 standard deviations then the children is defined under protein energy malnutrition. Wasting that is weight for height may indicate recent weight loss in a child while stunting, height for age usually results from chronic weight loss. The other type of undernutrition is micronutrient deficiency. This condition can result from the absence of essential vitamins and minerals from the diet which are essential for our body for proper growth and development. Some of the essential micronutrients are: Iron (Fe), Calcium (Ca), Iodine (I), vitamin A, B-vitamins and vitamin C (Ascorbic Acid). In developing countries the deficiency of iron, vitamin A and zinc are observed to be major problems whereas the deficiencies of vitamin C, vitamin D and vitamin B complexes are considerably declined in recent decades. Worldwide at least 2 billion people are affected by micronutrient deficiencies. The deficiency of these micronutrients may result in different deficiency diseases depending upon the particular nutrient that is lacking. The common micronutrient deficiencies found in humans are given in the Table 1.

Table 1: Micronutrient deficiencies and resultant diseases

Micronutrient	Deficiency Disease
Iron	Anemia
Iodine	Goiter, Mental retardation
Vitamin D	Rickets, bone loss, muscle weakness
Vitamin B12	Megaloblastic anemia, impaired brain function
Calcium	Osteoporosis
Vitamin A	Impaired Vision, Blindness
Magnesium	Muscle Cramps, Fatigue

Protein energy malnutrition is classified into three types. They are: kwashiorkor, marasmus and marasmic kwashiorkor. These are the clinical syndromes of the most extreme forms of protein energy malnutrition.

1.1. Kwashiorkor

The name kwashiorkor was first termed in 1935 by Cicely D. Williams. The term was taken from the Ga language which is spoken in Ghana which means sickness of the weaning. Kwashiorkor is caused due to the intake of a diet which has inadequate protein supply, but a normal range

of calories. Mostly older infants and young children are affected by kwashiorkor, characterized by edema which is fluid retention, dermatosis, hypo-pigmented hair, distended abdomen and hepatomegaly that is the enlargement of liver. The edema is caused because of the increases cortisol levels with low serum albumin level and inability to activate the antidiuretic hormone.

2. Marasmus

Marasmus is a common clinical syndrome which occurs due to the severe scarcity of calories and other nutrients. It is characterized by the depletion of the fat stores under the skin, muscle wasting and an absence of edema. Mostly children who are younger than 5 years are affected because their calorie intake requirements are higher and also are more susceptible to infections but other age groups can also be affected if severe malnutrition is present. Marasmus is different from kwashiorkor as in kwashiorkor only protein deficiency is present while in marasmus all kinds of inadequate energy intakes are present which also include protein.

3. Marasmic kwashiorkor

A child suffering from marasmic kwashiorkor is characterized by the symptoms of both marasmus and kwashiorkor. The affected children are stunted and wasted along with the presence of edema. Overnutrition can be defined when a person's intake of the macronutrients is much larger than the recommended dietary intake. It can also be caused if a person is expending very little amount of energy and intake is very high; mostly it is the combination of both conditions. Both undernutrition and overnutrition can be determined by using a scale or an indicator known as body mass index (BMI). Both lean and fat components are included in BMI and possess different importance in overnutrition and undernutrition. BMI can be calculated for an individual by taking the bodyweight in kilograms and dividing it by height in meter square (Table 2).

Table 2: Classification of individuals on the bases of BMI

Classification	BMI (kg/m ²)
Underweight	<18.5
Normal weight	18.5-24.9
Overweight (preobese)	25.0-29.9
Obese	≥30.0
Obesity grade 1	30.0-34.9
Obesity grade 2	35.0-39.9
Obesity grade 3	≥40.0

3.1. Causes of malnutrition

There is a wide range of causes of malnutrition, be it climate or the increasing food prices, agricultural productivity,

dietary intake, certain diseases and many more. Malnutrition can be caused due to the reduced intake of macronutrient and micronutrients. It can be because of the food scarcity or other factors due to which the individual is unable to get the required nutrients. The unavailability of food in a particular region due to the failure in production of food because of harsh climatic conditions which increases the food shortages making it a major cause of malnutrition in a population. The increasing food costs because of which many families are unable to get access to right quantity of food and thus eventually end up being malnourished. The increased food costs result in the micronutrient deficiencies which adversely affect the cognitive development of children also weakens the immune system and increases the risk of infections. In disease-related-malnutrition the causative factors may be the reduced dietary intake due to the loss of appetite. Changes in cytokines, glucocorticoids, insulin and insulin-like growth factors are responsible for the reduction in the appetite sensation. In case of patients with GI tract surgeries, malabsorption can be a major cause of weight loss and malnutrition. In certain conditions the loss of nutrients may also occur like in case of person with severe burns or enterocutaneous fistulae, there may be excessive loss of a specific nutrient. The energy expenditure of patients with head injuries, trauma or burns is considerably higher than normal; in these cases the elevated energy expenditure is responsible for disease-related-malnutrition. In patients suffering with cancer malnutrition is a major problem. Due to the side effects of cancer therapy on gastrointestinal tract, the primary affects of cancer, elevated infection rates and the change in metabolism the patient results to be malnourished. HIV/AIDS is highly related with malnutrition, malnutrition known to retard the functioning of immune system which increases the risk of HIV transmission and HIV infection in turn increases the vulnerability of malnutrition. Children are more likely to get affected by HIV/AIDS from vertical transmission and may likely suffer from malnutrition, the survival chance of these children is very low.

3.2. Effects of malnutrition

Malnutrition can have a wide range of affects on an individual's health. Malnutrition can affect a person's body mass to altering the functions of various organs. Malnutrition can adversely affect the muscle function of a person, the depletion of the fat layer and muscle mass along with the organ mass, which results due to weight loss can be most obvious symptom of malnutrition. The proper functioning of muscle declines even before the changes in muscle mass starts to occur which suggest the inappropriate nutrient intake from the diet. Likewise when the nutrient intake is appropriate, the first signs of improvement are noticed in muscle functioning before the improvement in muscle mass. Malnutrition can affect the cardio-respiratory functions of an individual due to the depletion in the

cardiac muscle mass due to malnutrition. The depletion of the cardiac muscle results in the decreased cardiac output which in turn reduces the glomerular filtration rate (GFR) thus affecting the renal functioning of the individual. Severe malnutrition may be fatal due to diarrhea because the reabsorbing properties of colon are lost and due to the secretion of fluids and ions in the small and large bowel. Chronic malnutrition affects the normal pancreatic exocrine functioning, may change the intestinal blood flow and also the intestinal permeability. Malnutrition increases a person's susceptibility towards infections due to its impact on immune system.

Treatment for Malnutrition: There are two possibilities.

3.3. Food

The introduction of supplementary foods to individuals suffering from severe acute malnutrition (SAM). The remedial formulas to cure severe acute malnutrition such as F-75, F-100 and ready to-use therapeutic foods are commercially available for the treatment of malnutrition. All these formulas are made and fortified with vitamin A with the specific standards given by the world health organization (WHO). During the initial stage of the treatment, the patient having major medical complications with inadequate appetite are admitted in a in-patient department of a healthcare facility and are provided with the F-75 formula initially. The F-75 formula helps in the improvement of the metabolic functions and maintains the electrolytic balance in the patient. The F-75 formula is formulated in such a way that the patient doesn't gain weight rapidly which can be very dangerous for the patient. The moment when the patient with severe acute malnutrition stabilizes in the inpatient care, the F-75 formula is then interchanged with F-100 formula which helps in the gradual weigh gain and recovery of the lost lean body tissues. Apart from F-75 and F-100 formulas, the ready-to-use therapeutic food (RUTF) is also used for the treatment of severe acute malnutrition. RUTF includes a large variety of types of food like compressed food products, products in the form of spreads that are intentionally designed for the treatment of SAM. In RUTF the energy density is maintained very high up to 23kJ/g of product. RUTF products generally consist of a mixture made from milk powder, vegetable oil, sugar, peanut butter and a vitamin-mineral premix. RUTF can be stored at home safely without any refrigeration and can be even used in areas with very low hygienic conditions as the bacterial growth in RUTF is limited. The ready-to-use nature of these therapeutic foods helps in saving considerable amount of time, work, effort and money for the treatment of malnutrition. The international organizations like World Health Organization (WHO), United Nations International Children's Emergency Fund (UNICEF) and World Food Programme (WFP) have given



Fig. 2: Sustainable malnutrition

specific standards for the composition of RUTF.

4. Biofortification

Biofortification is the process of breeding of nutrients into the crops. Crops which are already rich in micronutrients like iron, zinc, retinol etc. are further biofortified with higher levels of minerals and vitamins during their growth in their seeds and roots. The process of biofortification provides a long term and sustainable strategy for the delivery of micronutrients to a population. With biofortification a population can receive all the essential micronutrients that could help in naturally decreasing anemia, congenital impairment, poor nutrition related disorders and other malnutrition related issues. About 40% of women and children globally are affected by micronutrient deficiencies in developing countries especially iron deficiency which results in anemia. In such populations the consumption of meat is not affordable because of low income, so their diet is mainly based on legumes and cereals. Legumes and cereals contain elements which inhibit the absorption of iron making it the main reason of iron deficiency in the population. In order to increase the bioavailability of such nutrients in crops biofortification is done (Table 3).

Table 3: Examples of biofortified crops

Biofortified substances	Plants
Iodine	Spinach
Selenium	Onions and Carrot
Iron, Copper, Zinc	Wheat
Zinc	Rice
Protein, Fe and Zn	Chickpea
Iodine and Selenium	Lettuce

5. Conclusions

Malnutrition can be considered as an obstruction in the path of development globally. The inadequacy to supply ones family with the basic needs for the proper nutrition due to poverty or other reasons is a global issue. Forth elimination of these problem the phenomena of biofortification has to be implemented. Supplying all the essential nutrients in all the food products that can bring fruitful result by people

worldwide. Along with biofortification, treating the issue by using the RUTF's and the formula's like F-75 and F-100 is also to be used for a sustainable malnutrition.

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7. Conflict of Interest

The authors declare no conflict of interest.

References

1. Younis K, Ahmad S, Badpa A. Malnutrition: causes and strategies. *J Food Process Technol*. 2015;6(434):2.
2. Saunders J, Smith T. Malnutrition: causes and consequences. *Clin Med (Lond)*. 2010;10(6):624–7.
3. Saeed F, Imran M, Tufail T, Imran A. Introductory Chapter: Malnutrition; 2020.
4. Müller O, Krawinkel M. Malnutrition and health in developing countries. *Cmaj*. 2005;173(3):279–86.
5. Ritchie H, Roser M. Micronutrient deficiency. Our World in data; 2017. Available from: <https://ourworldindata.org/micronutrient-deficiency>.
6. Grover Z, Ee LC. Protein energy malnutrition. *Pediatr Clin*. 2009;56(5):1055–68.
7. Kim M, Basharat A, Santosh R, Mehdi SF, Razvi Z, Yoo SK, et al. Reuniting overnutrition and undernutrition, macronutrients, and micronutrients. *Diabetes Metab Res Rev*. 2019;35(1):e3072.
8. Malina RM, Katzmarzyk PT, Siegel SR. Overnutrition, undernutrition and the body mass index: Implications for strength and motor fitness. *Med Sport Sci*. 1998;43:13–26.
9. Schaible UE, Kaufmann SHE. Malnutrition and infection: complex mechanisms and global impacts. *PLoS Med*. 2007;4(5):e115.
10. Delbecque-Boussard L, Gottrand F, Ategbo S, Nelken B, Mazingue F, Vic P. Nutritional status of children with acute lymphoblastic leukemia: a longitudinal study. *Am J Clin Nutr*. 1997;65(1):95–100.
11. Skohn I, Axelsson K, Ghannad P, Hernell O, Wahlin YB. Nutrient intake and weight development in children during chemotherapy for malignant disease. *Oral Oncol*. 1997;33(5):364–8.
12. Hsu JW, Pencharz PB, Macallan D, Tomkins A. Macronutrients and HIV/AIDS: a review of current evidence. Durban, South Africa: World Health Organization; 2005.
13. Bunn JE. Severe acute malnutrition and HIV in African children. *Hiv Therapy*. 2009;3(6):595–611.
14. Manary MJ. Local production and provision of ready-to-use therapeutic food (RUTF) spread for the treatment of severe childhood malnutrition. *Food Nutr Bull* 2006 Sep;27(3 Suppl):S83–9.
15. World Health Organization. (1999). Management of severe malnutrition: a manual for physicians and other senior health workers. World Health Organization; 1999.
16. Briand A, Lacsala R, Prudhon C, Mounier B, Grellety Y, Golden MH. Ready-to-use therapeutic food for treatment of marasmus. *Lancet*. 1999;353(9166):1767–8.
17. Saltzman A, Birol E, Bouis HE, Boy E, Moura FFD, Islam Y, et al. Biofortification: progress toward a more nourishing future. *Global Food Security*. 2013;2(1):9–17.
18. Haas JD, Beard JL, Murray-Kolb LE, Mundo AD, Felix A, Gregorio GB. Iron-biofortified rice improves the iron stores of nonanemic Filipino women. *J Nutr*. 2005;135(12):2823–30.
19. World Health Organization. (2008). Worldwide prevalence of anaemia 1993-2005: WHO global database on anaemia.
20. Tako E, Laparra JM, Glahn RP, Welch RM, Lei XG, Beebe S, et al. Biofortified black beans in a maize and bean diet provide

more bioavailable iron to piglets than standard black beans. *J Nutr.* 2009;139(2):305–9.

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