



Food Security and Human Health

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Abstract

Eradication of hunger is one of the sustainable development goals listed by the United Nations. By 2050 the expected world population would be 10 billion and to provide food for all, we need to prioritize food security. A robust food security ecosystem will help to ensure that hygienic, nutritious food is available to the general population of a country. A decrease in the production of nutritious and safe food or limited purchasing power of consumers leads to food insecurity. Individuals facing financial constraints are affected the most because of food insecurity and hence are at a high risk of hunger and malnutrition. A deficiency, excess or imbalance of certain nutrients in the diet leads to malnutrition. Malnutrition is often used synonymously with undernutrition, which can be because of a deficiency of protein and/or micronutrients in the diet. Among the micronutrients, iron, zinc, and folic acid deficiency is very prevalent and the leading cause of undernutrition. Protein-energy malnutrition leads to conditions like Marasmus and Kwashiorkor. The common infectious diseases associated with undernutrition are pneumonia, diarrhoea, malaria, measles, and AIDS. Thus, food insecurity poses challenges not only to addressing public health but also affects the overall economic growth and socio-political stability of any nation. Hence at the global level, several programmes have been envisioned by the World Health Organization and United Nations Standing Committee on Nutrition. In context to the Indian population, the Government of India has started implementing various initiatives to establish food security. However, issues such as climate change, drought, floods, demographic changes, wars, increasing global population and pandemics need to be constantly addressed to achieve sustainable developmental goals. In this review, we have discussed what food security is and how in its absence, malnutrition predominates in a sizable population, especially children. The consequences of nutrient deficiency and their relationship with immunity and infection are highlighted and finally, the efforts that are being taken to tackle food security at a global level and in context to Indian issues are discussed.

Keywords: Food Security, Hunger, Malnutrition, Sustainable Development, Under-Nutrition

1. Introduction

During the Bengal famine in 1943, nearly 2-3 million people died due to starvation and other diseases related to malnutrition¹. After attaining independence, the Bihar drought in mid mid-1960s and the 1972 drought in Maharashtra, again exposed India's weakness on the food security front. However, by this time the Government of India had started formulating policies to deal with the harsh outcomes of such calamities. The Green Revolution (the early 1970s), mainly led by Dr. M. S. Swami Nathan, enhanced agricultural productivity because the farmers started using fertilizers and seeds with high-yielding capacity, and minimized the use of pesticides. The increased food grain production reduced food insecurity by 50% despite the increase in population which had almost doubled in that period. Soon after the Green Revolution, Operation Flood, which is also termed the white revolution (1970) was launched.

This initiative tremendously increased milk production in India, transforming it from a milk-deficient nation to being the largest producer of milk. The post-2000 period has taken us to the production of hybrid and high-yielding varieties of different crops, like maize, wheat, millet, and sunflower.

Today India stands in a position where it is self-sufficient to take care of its food needs. It no more imports food. From 1950 to 2014, the production of food grain in India increased by fivefold reaching an average production of 250 million tonnes of food². In the last decade, India has witnessed a steady increase in its exports of agricultural and processed food. However, over the coming decades, the growing global population, changing climate, escalation in food prices, various environmental stressors, epidemics, and pandemics will significantly affect our food security system. The World Food Programme, 2020 report states that the worldwide spread of Covid 19 infection

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has added approximately a quarter of a billion people to those already suffering from hunger and malnutrition.

The United Nations (UN) in 1987, defined sustainable development, as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. To achieve a sustainable future, in 2015 UN defined a set of 17 Sustainable Development Goals (SDG) goals which should be met by all countries by 2030. Some of them that are directly linked to food security are no poverty, zero hunger, clean water and sanitation, good health and well-being, responsible consumption and production and climate action. SDG goals 2 and 3 which aim at eradicating hunger and bringing good health to all can't be met by any Nation until and unless they can achieve self-sufficiency not only in the production of food but also its equitable distribution. According to the World Food Summit (WFS), there is enough food for direct human consumption, but its distribution is uneven.

In this review, we have discussed what food security is and how in its absence, malnutrition predominates in a sizable population, especially children. The consequences of nutrient deficiency and their relationship with immunity and infection are highlighted. Food insecurity poses challenges not only to addressing public health but also affects the overall economic growth and socio-political stability of any nation. Finally, we have discussed the efforts that are being taken at the global level and in context to India to tackle food security issues.

2. Food Security

Food security, as explained by the United Nations Organization (UNO), means that safe and nutritious food in sufficient amounts is always available for the general population of a country. Food security is directly linked to the health of individuals and the social and economic productivity of a nation. The access to food in turn is dependent on the availability of food. Food security not only refers to the availability of food but also its access and utilization by the general population. The availability of food in India today is sufficient, but the issues of access and utilization need to be addressed. The incidence of malnourishment is high in India despite the existence of a large stock of food grain³. Furthermore, the issue of food stability which refers to the ability to always obtain food, also needs to be addressed. Food stability can be affected by threats from nature in the form of floods, earthquakes, pandemics, droughts, wars etc. and the nation must be prepared to face such calamities.

3. Food Insecurity

Food insecurity means a lack of sufficient food. Food insecurity issues are mostly prevalent in individuals who are facing problems in their daily bread and butter routines, have no shelter, are compromised to dwell in unhygienic environments and are facing extreme hunger which leads to malnutrition or undernutrition⁴. A decrease in the production of nutritious and safe food or limited purchasing power of consumers leads to food insecurity⁵. Lack of potable water, sanitation and unhygienic (WASH) conditions also lead to food insecurity. Food insecurity can be seen at many levels (i) individual (ii) households (iii) regional (iv) national (v) international. According to the data presented by the Global Hunger Index 2022, India ranks 101 among 116 countries⁶. According to UN-India, there are nearly 195 million undernourished people in India, which is a quarter of the world's hunger burden. Approximately 43% of children in India are chronically undernourished and hence cannot meet their full potential. Chronic undernutrition results in stunting, wasting and underweight. India recorded the highest child-wasting rate in the world, at 17.3% during 2016-2020 and 34.7% of children under the age of five were affected by stunting.

4. Malnutrition

Malnutrition refers to an imbalance between the supply of nutrients and energy and the body's demand for the same. Energy is always required by the body to perform all its functions at the cellular and organism level⁷. Either an excess or deficiency of a particular range of macro and micronutrients can adversely affect the various physiological or biochemical processes in the body. Malnourishment can be either under-nourishment or over-nourishment, however, malnutrition is most often associated with under-nutrition, which includes conditions like wasting, stunting and underweight. Malnutrition is related to micronutrient deficiency and is commonly seen in people who are poor and hence have limited access to food or are more vulnerable to price spikes in food. One of the major reasons for malnutrition is poverty. Poverty can be due to several reasons like natural disasters, poor Governance, low literacy etc⁸. Sometimes due to poor hygiene in low-income groups, people suffer from stomach disorders (bowel infarction) which may remove the nutrients from the body, making them malnourished. Hidden hunger is also a kind of malnutrition due to a deficiency of micronutrients⁹. Malnutrition mostly affects adolescent girls and children in developing countries¹⁰. Overnutrition is often observed in families of high-income groups. These individuals are on an energy-rich diet with no physical activity resulting in various health issues related to obesity, hypertension, and stress¹¹.

5. Under Nutrition

An undernourished person is consuming a diet with inadequate amounts of vitamins, minerals, proteins, carbohydrates or fat essential for growth. Several epidemiologic studies done across the globe show that more than 50% of all childhood deaths are attributable to undernutrition. According to data given by different organizations like the State of Food Security and Nutrition in the World (SOFI) 2020 and the United Nations Food and Agriculture Organizations, about 690 million people were reported to be undernourished in 2019 which is approximately 60 million people more than the 2014 depicted data¹². By 2020, the number of under-nourished children rose from 83 to 132 million, an effect attributed to Covid19 pandemic.

Undernutrition can be of two types: Protein Energy Malnutrition (PEM) or micronutrient deficiency. Undernutrition leads to delayed motor development, cognitive impairment, behavioural problems, immunodeficiency, and increased mortality and morbidity. PEM manifests early in life (6 months to 2 years), due to irregular or no breastfeeding and starting solid food with little or no protein content. It is measured by indicators such as wasting, stunting, and being underweight. Wasting is measured by Weight for Height/Length (WHZ) and stunting is given by Height-to-Age ratio (HAZ).

6. Protein Energy Malnutrition

Kwashiorkor and marasmus are two clinical outcomes associated with protein energy malnutrition. The main difference between the two is the presence of oedema in Kwashiorkor¹³. Kwashiorkor is a Ghanaian word, coined by Cicely D. Williams in 1935, for the disease that develops when a mother's first child stops taking breast milk and is fed a diet with predominance of carbohydrates and negligible amount of protein. It occurs mainly in young children, consuming a diet that lacks adequate protein but is not compromised on calorie intake. Clinically these children show marked generalized edema, distended abdomen, and hepatomegaly but the weight is normal for that age. Starvation of both protein and calories leads to a condition known as Marasmus, which is characterized by muscle wasting and loss of subcutaneous fat stores. Marasmus is mainly observed in younger children because their calorie needs are huge due to continuous growth. These children do not show signs of oedema, have weak immunity and are extremely susceptible to infections.

7. Micronutrient Deficiency

Micronutrients include vitamins and minerals which are required by the body in very small amounts. Micro-nutrients are required to produce enzymes, hormones, clotting factors, building immunity, growth, and development of an individual. Among the micronutrients, iron, zinc, and folic acid deficiency is very prevalent and the leading cause of undernutrition. The deficiency of these micronutrients leads to anaemia. When compared with food-secure children, those children who had limited access to food were found to be 2-3 times more susceptible to anaemia. According to the WHO 2016 report, anaemia is prevalent in children below the age of 5 years (42%) and pregnant women (46%)¹⁴. The WHO Global Nutrition Target 2025 is set to bring down anaemia levels in children by 50% by 2025¹⁵.

In a recent meta-analysis of micronutrient deficiency in India, it was seen that vitamin D deficiency (61%) was most common. This was followed by iron deficiency (54%), cobalamin deficiency (53%), folic acid deficiency (37%) and iodine deficiency (17%)¹⁶.

Women having micronutrient deficiencies of iron, folate, vitamin A, iodine, and zinc may give birth to low-weight babies, and when these deficiencies co-exist with other macronutrients it may lead to mental or physical retardation, poor developmental growth, and weak immunity of the offspring¹⁷. If the fetus is malnourished it will affect its entire life in terms of education, health and productivity¹⁸.

8. Malnutrition and Disease Prevalence

About 50% of childhood mortality is attributed to deficiencies and diseases related to undernutrition. The increased mortality rates are due to changes in physiology, leading to a state of altered homeostasis. Chronic malnutrition, especially in early life results in irreversible changes and is linked to poor development, impaired cognitive ability, and a weak immune system. Poor development of the thymus leads to decreased production of lymphocytes¹⁹. The Mucosal-Associated Lymphoid Tissue (MALT) provides defense against pathogens, like *Vibrio cholera*, *Escherichia coli*, *Listeria*, *Salmonella* etc. The nutritional status of an individual can alter the development of MALT. The mucosal lining of the gastrointestinal tract is often altered and inflamed in under-nourished children; hence translocation of pathogens becomes easy through this route and the chances of enteric infections become high²⁰⁻²³. In undernourished children, a lowered antibody response to bacteria is generated, who then become more prone to

common infections. Thus, both the innate and the adaptive immune mechanisms are altered in under-nourished children.

Malnutrition also alters levels of glucocorticoid hormones; released by the adrenal glands and adipokines which are released predominantly from adipose tissue^{24,25}. The fat cells secrete leptin, a satiety hormone which has an important role in immune cell activation. The concentration of leptin is reduced in children suffering from protein-energy malnutrition, thereby affecting their immune status. Glucocorticoid hormones regulate inflammation and promote thymic development. Diseases, namely AIDS, malaria, measles, pneumonia, and diarrhea are responsible for the high mortality rate observed in children below five years of age²⁶. Undernutrition can bring changes in the gut microbiota, disturbances in normal barrier function and increased risk of diarrhea²⁷.

Maternal malnutrition leads to epigenetic effects. Epigenetic modifications especially through methyl group addition can influence immune system development after conception²⁸. Recently the impact of paternal malnutrition has been studied in infants. It was observed to have an influence on the metabolism of newborns in a heritable manner²⁹.

9. Over Nutrition

Overnutrition in adults and teenagers can be due to the consumption of food which are high in calories and low in nutrients, basically, carbohydrate and fat-rich food, causing hyperlipidemia, diabetes, obesity, cardiovascular diseases, and sleep disorders³⁰. A study reported that women consuming a diet rich in carbohydrates and fat, with limited protein intake are 10.8% more likely to be obese than those taking a balanced meal³¹. In women who were moderately or severely depressed, the chance of diseases associated with over-nutrition rises by 50-80 %³².

10. Food Security Laws in India

The National Food Security Act 2013 (NFSA 2013) is executed in different states of India to address the issues related to food security. The NFSA 2013 of India relies on several secondary sources The National Family Health Survey (NFHS), The National Sample Survey (NSS) and the Indian Human Development Survey (IHDS). NFHS estimates malnutrition at the national and state levels. NSS records household consumption data and IHDS shows complete data on anthropometric measurements of children. Under NFSA, free cereals are distributed daily to children, pregnant women, and lactating mothers. Overall, the benefits of this act reach out to approximately two-thirds of the population in India, who can get access to food grains.

11. Food Security Schemes in India

To enhance the production of various food grains, various schemes are implemented by the Indian Government. Several schemes, viz. National Food Security Mission (NFSM), bringing Green Revolution in Eastern India, Rashtriya Krishi Vikas Yojana (RKVY) etc., are implemented by the Government to provide high-yielding varieties of different crops and hybrid seeds to farmers. The Pradhan Mantri Fasal Bima Yojana (PMFBY) provides financial support to farmers facing crop damage issues arising out of unforeseen events, thereby ensuring sustainable production of food in times of calamities. The Integrated Scheme of Oilseeds, Pulses, Maize and Oil Palm (ISOPOM) is another venture of the government, to increase the production of oilseeds and pulses. The Food Corporation of India (FCI) investigates the effective transportation, dissemination, and storage of food grains, thereby ensuring equitable distribution and reducing the loss incurred due to suboptimal storage conditions.

To ensure the proper access of food to children and the various marginalized sections of the society, the Government of India (GOI), has introduced several schemes. The Targeted Public Distribution System (TPDS), introduced in 1997, ensures access to food by the marginalized sections of society. The Mid-day meal scheme reaches out to about 12 crore children in over 12.65 lakh schools all over India. The program aims at increasing attendance in schools and at the same time improving nutrition levels among children studying in local and government-aided schools all over the country. The GOI, in 2000 started The Antyodaya Anna Yojana (AAY) to feed the poorest of the poor, the Annapurna scheme for indigent senior citizens, and the Anganwadi systems to provide food to pregnant mothers. The distribution of fortified rice under the Public Distribution System (PDS) was initiated in 2019. The reports from the Food Safety and Standards Authority of India (FSSAI), reveal that fortification of food with essential micronutrients like iron, folic acid, cobalamins, iodine, vitamin A and vitamin D is being done to tackle deficiency of micronutrients^{33,34}.

12. International Food Security Schemes

Nutritious food is a primary determinant of human health. It is a basic human right to get good quality food daily. The Sustainable Development Goals (SDGs) aim to promote prosperity while protecting the planet. Sufficient, safe, and nutritious food is identified as relevant to all SDG and especially to SDG 2 (zero hunger) SDG 3 (good health and well-being) and SDG 12 (responsible consumption and production

pattern). Governments across the globe are formulating robust strategies to ensure the production and accessibility of food to the masses. Economic disparities within and across countries, including marked differences in the strength of national food productivity and laws, result in a complex dynamic situation. To overcome these issues the governments act at the global, national, and state levels to ensure food security.

The Draft WHO Global Strategy for Food Safety 2022-2030, highlights the importance of accessibility of safe and nutritious food to all people across the globe^{35,36}. The strategy's vision is to reduce the incidence of food-borne diseases. The United Nations (UN) priority group, which includes the United Nations Children's Fund (UNICEF), the Food and Agriculture Organization (FAO), the International Fund for Agriculture and Development (IFAD), the World Food Programme (WFP), United Nations Development Programme (UNDP), partner with the governments of different countries to provide nutrition services and improve feeding practices in the home. WFP, founded in 1961, is the food assistance branch of the UN and is focused on food security and hunger. The United Nations Standing Committee on Nutrition (UNSCN) aims to promote goodwill and cooperation among UN agencies. The mandate of the UNSCN is to end malnutrition.

13. Conclusion

The issue of food security is reflected in all the sustainable development goals. The SDG sets up a target for all countries, as they move towards the path of prosperity and a sustainable future. Production of sufficient, safe, nutritious food and its access to all is relevant to achieving SDG. The inter-relationship between good health and well-being, nutrition, food security and socioeconomic development cannot be ignored. There is a growing awareness worldwide of the need to strengthen national food security systems in response to current and emerging food security challenges. The FCI, NFSM, BGREI, RKVY, PMFBY and TDPS play major roles in the food security of India. To meet and adapt to future challenges, there is a need to develop new cooperation models among governments, international institutions, companies, and research communities to define precise policies and measures towards achieving food security.

14. References

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