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Nutritional requirements, food insecurity and COVID-19: An outlook for comprehensive view

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Abstract
Background: With the growing cases of COVID-19, every single person of the society is in a great challenge to meet their needs, either it is economic, social, or health-related. Malnutrition is another factor which is of more significance due to household food insecurity triggered by COVID-19. Looking into the inconvenience caused due to COVID-19, this review provides an outlook towards the food insecurity and the nutritional needs of the individuals to endure through the unforeseen pandemic situation.
Methodology: A literature review.
Results: Review findings suggest that the COVID-19 aggravates the global burden of malnutrition. Physical access to food and economic commotion is the major setback caused due to pandemic. Moreover, the elderly and children are the two highly vulnerable groups that have increased risk of COVID-19. Since older people have a pre-existing medical illness, therefore the risk of disease increases. To meet the nutritional needs and boost the immune system, nutrients like Vitamin A, D, C, E, B-complex, especially B_6 and B_{12} along with iron, magnesium, and zinc are of paramount importance in sustaining the immune system.
Conclusion: It can be concluded that the COVID-19 pandemic has made people realize the healing potential of food and the importance of consuming nutrient-rich immunity-boosting food. Nonetheless, the burden of food insecurity has led to increased incidence of malnutrition and food inaccessible to the large mass, thus strengthening the health system is of extreme importance. However, it is advocated that the use of restorative nutrient-dense foods is the sole generalized treatment and cure for the people recovering from this illness.

Keywords: COVID-19, malnutrition, food insecurity, nutritional needs, immunity boosting foods

Introduction
The food and nutrition security of the world is severely affected due to COVID-19 challenging times. It has caused an unparalleled impact on the livelihood of millions of people leading to severe health complications. The presence of an agent and susceptible host in the adequate proportion and the causative agent can be successfully transferred from the source to susceptible hosts is referred to as an epidemic. The sudden increase in virulence of the agent, the recent introduction of the agent into a setting where it has not been before, an enhanced mode of transmission so that more susceptible persons are exposed, change in the susceptibility of the host response to the agent, and factors that increase host exposure or involve introduction through new portals of entry are various factors leading to an epidemic. Pandemic refers to an epidemic that has spread over several countries or continents, usually affecting a large number of people [1]. The major killers in human history are Cholera, bubonic plague, smallpox, and influenza.
Recently spread zoonotic coronavirus is a member of *Orthocoronavirinae* subfamily comprising of α, β, γ and Δ strains of coronaviruses (CoVs) [2]. The global outbreak of the deadly COVID-19 disease, caused by severe acute respiratory syndrome coronavirus-2 (SARS COV-2) has led to bizarre on health concern [3]. Corona represents crown-like spikes on the outer surface of the virus; thus, it was named as a coronavirus. Prominent symptoms associated with the disease are trouble in breathing, persistent pain, and pressure in the chest, fatigue, bluish lips, or face. Pneumonia is the dominant clinical manifestation of the disease. The presence of metabolic disorders like cardiovascular diseases, diabetes, kidney problems, and malnutrition further complicates the situation as such individuals are more prone to developing COVID symptoms. Looking at the severity of this virus, the World Health organization in March 2020, declared coronavirus as a pandemic and vowed it as a public health emergency of international concern [4].

As per the WHO dashboard, the total number of confirmed cases globally counts to 13,616,593 with 585,727 deaths as of, 17th July 2020.

Various clinical trials are being carried out all over the world, but there has no vaccine or treatment confirmed so far. Hence, it is through proper nutrition and healthy lifestyle practices that we can fight this condition. Therefore this review deals with the food security and nutritional aspects of dealing with the novel coronavirus.

Search methodology

We have carried out an online search on PubMed (National Library of Medicine, Bethesda, MD), Google Scholar, and Web of Science. WHO dashboard on COVID-19 was also accessed.

Food Insecurity and Covid-19

Food insecurity is the disruption in the consumption pattern due to lack of money or other resources insecurity [5]. It is influenced by a number of factors including income, employment, race, and disability status. This, in turn, leads to negative health outcomes like developing nutritional deficiencies, impaired cognitive development, and chronic diseases. Food security is directly related with the positive health and nutrition of individuals. The world was already burdened with the issue of malnutrition, which is further aggravated by the COVID-19 pandemic. Pockets of food insecurity have appeared in every country and population groups that were not traditionally affected. As per achieving Sustainable development Goals of eradicating hunger seems more daunting due to the current condition. The malnutrition is the result of food insecurity among vulnerable groups like women, children, and the disabled [6]. There had been a decline in food insecurity and hunger since the 1990s throughout the 2000s; however, it came to an end five years ago. The sudden outbreak of COVID-19 brought an end to the optimistic evolution that took in the first part of the 21st century.

Major breakdown in the economy has led to hunger and food insecurity, especially in developing countries and poor communities. Strengthening the health system is of utmost importance to support critically ill patients; however, adequate and nutritious intake of the food is the sole cure for the people recovering from the illness. Various organizations of the world like FAO, WHO, UNICEF, IFAD, WFP, ICMR, and FSSAI are continuously involved in providing guidelines in overcoming the adverse situation. The countries are struggling hard to strike a balance between the unstable economy and the safety of the people while ensuring the poor and nutritional needs of the vulnerable population. The worst scenario is being faced by emerging countries where the food supply depends on the import. Physical access to food and economic commotion is the major setback caused due to pandemic [7]. There are has been a disruption in the complete food supply management. From the grass root level of inputs that include in agriculture (labor, seed, animal feed, fertilizer, and pesticides) to harvesting, processing, storage, transport to wholesale/retail markets, the entire process is hindered. The supply of perishable like fresh milk, fruits, vegetables, meat, and fish that are essential to maintain our health has been affected. Conflict-affected regions are the victims of food insecurity. There have been impulse purchases of foodstuffs like ginger, turmeric and other immune-boosting remedies, leading to their scarcity in the markets. This in turn leads to a shortage of the unaware and unprivileged section of the society. Food and Agriculture organization had reported three scenarios of hunger all around the world post-COVID-19 pandemic. Among the unprivileged section, it is women and girls are at higher risk of food insecurity. This trend is more prevalent among the poor and lesser-educated segment of the population, and unemployed, with health problems and living in suburbs of large cities compared with those who live in rural areas [8]. These women are frontline workers, including nurses, doctors, food industries, garment, agriculture, construction, and retail industry.

Global status of malnutrition during the current COVID-19 pandemic

The nutrition status of vulnerable sections of society is always compromised. COVID 19 is not treating everyone with equality. The unprivileged people, with insufficient availability of food and hygienic conditions, are the most vulnerable section of the society. The only defense strategy to fight this condition is proper nutrition. Malnutrition is the single largest cause of a large number of diseases. Nine out of ten children in Africa and Asia was stunted in the year 2019, representing about 40 percent and 54 percent population, respectively. Globally, the stunted population constitutes around 144 million. There was a reduction in such population between the years 2012 to 2019; however, this is not sufficient to achieve 2025 and 2030 targets of achieving a reduction in stunting under Sustainable Development Goals. There is no improvement in the global prevalence of overweight among children under five years of age, rising from 5.3% in 2012 to 5.6% in 2019. Of this, 69 percent lived in Africa and Asia, constituting the world's majority of undernourished people.

Not only child obesity but adult obesity is increasing at an alarming rate. Due to the over-burdening of health systems, curative and preventive services, including antenatal and child care is dangerously affected. In children, this leads to wasting, thus affecting health and nutritional status leading to mortality [9]. Many people already suffering from non-communicable diseases are no longer able to access the medication required for their treatment [10]. Figure 1 shows the never-ending vicious cycle of malnutrition. Several factors leading to malnutrition are depicted in Figure 2. Poor health leads to reduced productivity, in turn leading to poverty and unemployment [11].

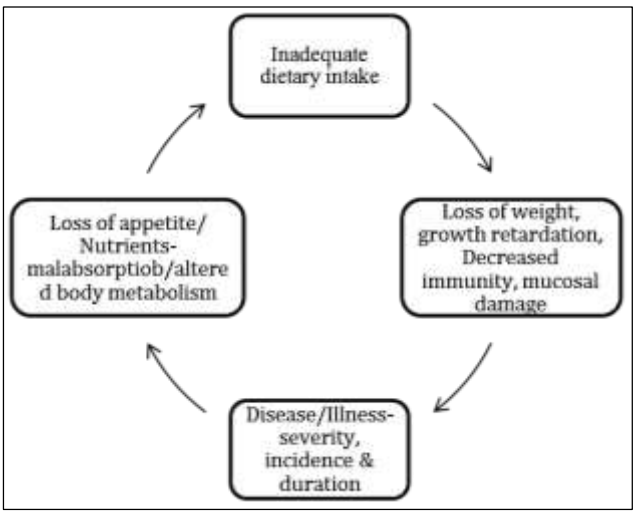

Fig 1: Vicious Cycle of Malnutrition and Infection

Adapted from Fenn B. Malnutrition in Humanitarian Emergencies [11]

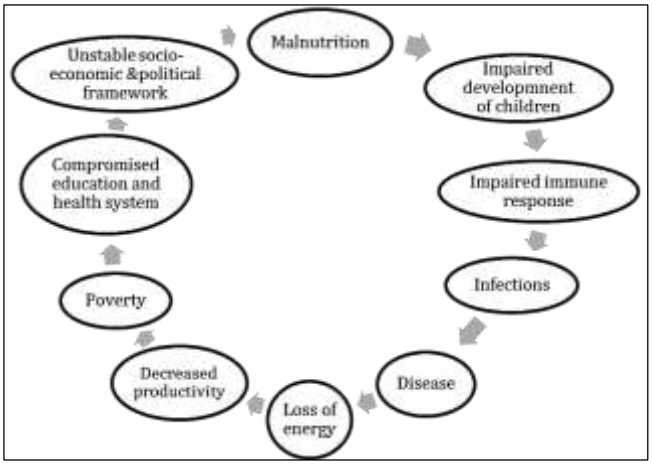

Fig 2: Malnutrition-Infection-Disease Interaction

Adapted from Fenn B. Malnutrition in Humanitarian Emergencies [11]

Fig 3: Factors affecting the quality of the diet of individuals

Thus, this pandemic has made the situation worse for the people already in the crisis. The poor people, women, children, and the un-sheltered people who are both affected by the virus and the containment measures. The malnourished population is more susceptible to infections and viruses. It is not a matter of personal choice, but the unaffordable cost makes it inaccessible for the large mass. Dealing with the current state of crisis, our diet should be sufficient in energy, nutrient adequate, and balanced. Figure 3 shows the primary factor to be kept in mind to maintain the quality of food.

Role of nutrition in global food security

The concept of a healthy diet differs upon individual characteristics, cultural influence, availability of food, cultural and environmental variation. However, the requirement needs to be fulfilled for various macronutrients and micronutrients in appropriate proportions. As per the Food and Agriculture Organization and the World Health Organization, a minimum of 400 g/person/day fruits and vegetables shall be consumed by the individuals. But the diet of wretched and unprivileged mainly relies on staple lacking vitamins like A, C, D, and minerals like iron and calcium. People experiencing moderate to severe food insecurity are unable to afford dairy products, meat, and fresh fruits [12, 13]. The global nutrition targets can only be achieved by consuming a diversified diet consisting of food from different food groups only then the sustainable development goals can be achieved [14]. There is a considerable impact on overall diet quality and nutrition through disruption in food systems due to this pandemic. The health and well-being of the people is negatively impacted. There is an increased demand for low-cost foods and drinks that contain a high amount of sugar, which is directly proportional to overweight and obesity among adults and children [15, 16]. Affordability is the primary factor governing food choices. Therefore, the food industry and policymakers shall focus on developing the recipes that can be easily accessible by all sections of the society. Figure 4 illustrates the impact on the choice of food during the current COVID-19 situation.

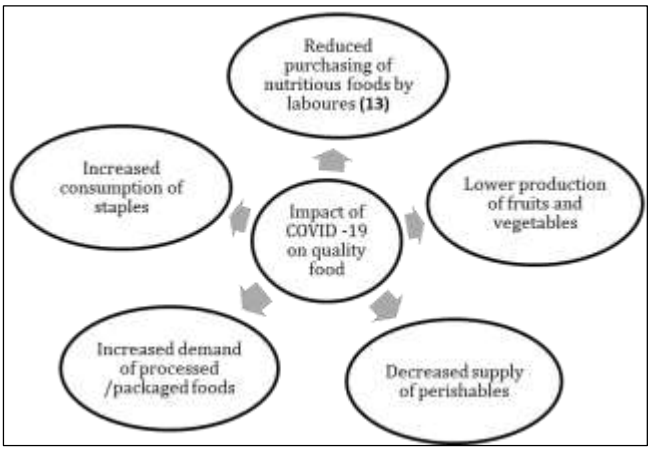

Fig 4: Impact of COVID-19 on quality of food

Risk mitigation strategies on food security and nutrition

FAO defines some of the measures to attenuate the current food crisis. These include emergency food assistance to the vulnerable sections of the country to their households by the food groups and social agencies, small farmer's loans shall temporarily be waived off by the banks as their fresh produce has resulted in huge loss and the export trade shall be permitted among the countries, taxes shall be reduced by the state to stabilize the food markets [8]. Nearly all governments in the region have responded with a range of social protection measures. Relief in the form of cash transfers and unemployment benefits, provision of food in kind (e.g., school feeding) or through vouchers, wage subsidies, and waiver or postponement of utility bills shall be applied [17]. For pre-existing programs, governments have implemented vertical expansion (increased benefits for those already covered), horizontal development (an increase in the number of people included), and accelerated payment of benefits. The new programs have been introduced by the government of various countries like India. One of the Indian states of Kerala has displayed an excellent example of governance and management by providing 35kg of rice per month for below the poverty line population. Free meals are offered to the children below six years of age by Anganwadi workers. The other states also adopted this model by delivering wheat and

rice to overcome the distressing situation of hunger. In Bolivia, FAO has provided farming families with technical assistance, training to improve agricultural production by proper handling, good hygiene practices, good agricultural practices, and manufacturing methods. They are being trained to develop new markets with better negotiation skills and price setting. This situation has given rise to the concept of minimalist living and reducing wastage. Depending upon the future spread of the virus, governments may need to provide more assistance for a longer period of time. Providing more benefits will be a challenge for all countries, but especially for low- and lower-middle-income countries. International migrants, both formal and informal, may be among the most vulnerable as they may or may not receive social protection coverage in either their country of residence or their home country [18].

Expand social protection, in the short-term as part of countries' economic stimulus measures, to cover more people and provide more generous benefits to ensure food access for all, while also reducing the administrative burden needed to access the funds [19].

Nutritional requirements and its role in COVID-19

The trauma of COVID-19 has laid every single person of the society a great challenge to meet their needs; either it is economical, social, or health-related requirements. The rate of malnutrition has increased with the growing shortage of food at the household level due to economic insecurity that occurred by COVID-19. Elderly and children are the two highly vulnerable groups that have increased risk of COVID-19. Since elderly people have a pre-existing medical illness, therefore the risk of COVID increases. However, children especially from low-income families, also require urgent nutritional support to meet their requirements during the pandemic. The shutdown of educational intuitions due to COVID-19 had led to a halt in the school-based meal program; which was known to satisfy almost 2/3rd or 66% of the daily dietary and nutritional needs of children [20]. An estimate of the United Nations indicated an increased risk of acute hunger in over 300 million children who were dependent on school-based meals [21]. Recent estimates suggest that this pandemic will lead to an increase in the rates of infant and below five child mortality rates due to disruptions in the health sector and lack of access to food. The estimations for India report a potential 10,000 to 50,000 child deaths per month while 500 to 2500 maternal deaths from the moderate to severe scenarios [10].

Nutrition/ Immunity/COVID-19

The immune system protects the host against harmful environmental agents such as pathogenic microorganisms, including bacteria, fungi, and viruses. This diverse network of immune system works consistently, yet the cells become most active by the invasion of a pathogen. The activated immune system demands a huge supply of energy-yielding nutrients like glucose, proteins, and fatty acids. Therefore it is necessary to have good dietary intake along with efficient stores of nutrients required by the activated immune system to initiate the creation of immunoglobulins, cytokines, adhesion molecules, and certain lipid-based mediators, for example, prostaglandins and leukotrienes [22]. In total, the adequate intake of both macro and micronutrients is essential for dealing with the nutritional requirements of fighting against Coronavirus. Inclusion of immunity-boosting nutrients like Vitamin A, D, C, E, B-complex especially B_6 and B_{12} along with iron, magnesium, and zinc are of paramount importance in sustaining the immune system through regulating gene expression, maturation or differentiation of immune cells [23]. Altogether, the basic building block of protein, specifically amino acids such as arginine are involved in the production of polyamines, which helps in regulating DNA replication and cell division. Hence essential amino acids should be included in the diet to help boost the immune system [2].

Additionally, balanced nutritional and dietary status takes into account better strength and resilience in the situation, for example, on account of COVID-19 infection. A study done by Bruguiera & others reported that by following the Malnutrition Universal Screen Tool (MUST), a total of 45% COVID-19 patients showed a high risk of malnutrition while 26% of patients showed moderate risk [24]. Besides, Malnutrition among COVID-19 patients is mostly brought about by the reduced dietary intake caused by nausea, diarrhea, and the lack of appetite. Meeting the nutritional needs of malnourished patients is another challenging situation since malnutrition may defer the quick healing processes and thus increase the period of stay in hospitals. Moreover, malnutrition impairs the immune response, hindering the immune function that is necessary for safeguarding against the infection [22]. Subsequently, the prevention and management of malnutrition among COVID-19 patients through proper dietary regime at hospitals should be warranted [25].

Also, Nutritional assessment of COVID-19 patients is vital for scaling up the nutritional needs which could be fulfilled by oral, enteral, or parenteral feeding. To reduce the growing threat caused by COVID-19, personalized meal plans along with the oral supplements would be necessary to meet the growing protein and energy requirements of the patients on an oral diet while for those having difficulty in eating can be supported through enteral or parenteral feeding formulas comprising of high protein and low glucose levels, meeting the ESPEN recommendations for care at intensive care unit [26]. Studies have demonstrated that the COVID-19 patients with no risk of malnutrition should maintain the nutrient adequacy, particularly in terms of calorie (25-30Kcal/day/ Kg body weight), protein intake (1.5g/day), and micronutrients such as vitamins with gigantic antioxidant as well as anti-inflammatory properties [27, 2] while the nutrient recommendations are rather high for malnourished patients. Table 1 presents the food sources that are recommended to boost immunity.

Table 1: Immune boosting food sources

S. No.	Immune-boosting foods sources	Major Nutrient
1.	**Citrus fruits:** Avocado, Amla (Indian gooseberry), Orange, Lemon, Strawberries and Tomatoes **Vegetables:** Capsicum, cauliflower, brussels sprouts, Potato	Vitamin C
2.	**Animal foods:** Fatty fish (salmon, mackerel, and tuna), egg yolk, low-fat yogurt **Vegetables:** Mushroom	Vitamin D
3.	**Vegetables:** Spinach and Broccoli	Vitamin E

	Nuts: Almonds, Peanut, Hazelnut **Vegetable oils:** Sunflower, Soybean, Safflower, Corn and Wheat germ oil	
4.	**Fruits:** Papaya, Mango, Apricot, Peaches, **Vegetables:** Green leafy vegetables (Spinach, Lettuce), Red bell pepper, cantaloupe, broccoli, sweet potatoes, and carrots	Vitamin A
5.	**Grains:** Whole grains, millets (Sorghum, barnyard millet, foxtail millet), fortified cereals **Animal foods:** Meat, Egg, Molluscs, **Vegetables:** Roots (Beetroot, carrot), Green leafy vegetables **Nuts:** Dried apricot, Dates	Iron
6.	**Vegetables:** Green beans **Animal foods:** Meat, Oyster, Shellfish, Chicken, Pork **Nuts and seeds:** Cashewnut, Almonds, watermelon seeds **Grains:** Whole grains	Zinc
7.	**Animal foods:** Yellow Tuna, Halibut, Oyster, Chicken, Egg **Grains:** Wheat, Brown rice **Nuts and seeds:** Brazil nut and Sunflower seeds	Selenium

Source: (Budhwar, Sethi & Chakraborty, 2020) [4]

Role of macronutrients

1. Energy

Energy is required for carrying out the key functions of the body including metabolism and body repair, along with this energy is helpful in the generation of proteins and immune cells to fight against infections and diseases [28]. The critically ill non-obese patients are recommended to have a daily energy intake of 25-30Kcal/ kg body weight while the energy intake of 21 Kcal/kg body weight is recommended for critically ill overweight plus obese patients [29].The energy needs of the children per unit body weight are thrice as high as grown-ups. The energy density of the child's diet should be kept high to meet the increased energy needs of the growth phase of the life span. On the off chance, if the energy density of the child's diet is low, even normal fed children may not be able to eat a sufficient amount as the food turn out to be bulky. Energy density is mostly influenced by the water and the fat content, the more the water content of the diet the lesser the energy density. On converse the more the fat content of the diet, the more the energy density since fat provides a large number of calories (9Kcal/100g) as compared to carbohydrates and proteins which provides 4Kcal/100g [30].

2. Protein and amino acids

Amino acids play an essential role in the regulation of the immune cells therefore the requirements for them are also high. The protein needs of children during illness depends largely on the body stores of amino acid and the requirement for growth and tissue building. During the times of illness, a major amount of protein is utilized for meeting the requirements for metabolism due to the insufficiency of energy [31]. Research has shown that the inclusion of high biological value quality proteins (ex- milk, egg, legumes) into the diet of ill, rehabilitated, or malnourished children have a tremendous positive impact on the growth in children [32].

Supplementary and infant feeding foods enriched with soy flour/ soy protein isolates are most often used as protein food; provided that soy flour being processed beforehand for anti-nutrients, dietary fibers, and phytohormones. Animal-based foods contain a good amount of micronutrients like zinc, iron, etc. along with good quality digestible protein [33], the inclusion of such foods into the diet of children will have twining action of meeting the dietary needs and boosting immunity. Milk and milk-based products are also beneficial following linear growth in children [34]. Altogether the intake of lysine and arginine are effectively associated with the release of growth hormones through somatotropic axis [32]. Also, the branched-chain essential amino acids should be included in the diet to meet the needs during rehabilitation in the COVID-19 situation [2].

3. Fatty acids

Essential fatty acids (MUFA and PUFA) play a key role in boosting the immune system by activation of the immune response by the production of prostaglandins [22]. Omega-3 and omega-6 unsaturated fatty acids are the essential fatty acids that act as the substrate for the immune response. Hence these facts should be included in the daily diet. Inclusion of unsaturated fats obtained from nuts, avocado, fish, soy, sunflower, canola, and corn oil would be of great health benefit while the exclusion of saturated fats obtained from butter, ghee, cream, meat, and lard should be avoided [9]. Studies have shown that the PUFAs (Linolenic and Linoleic acid) have an essential anti-inflammatory plus pro-inflammatory immune response [4], thus would be beneficial to be included in the diet of children to fight the virus.

Role of Micronutrients

1. Iron

Iron is required for the production of red blood cells that carry oxygen to the body tissues. Iron helps boost immunity; nonetheless, its deficiency impairs the host immunity results in increased susceptibility to viruses plus infections [35] and recurrent infections of the respiratory tract in children [36]. Lower iron levels cause thymus atrophy and disturb the native T lymphocytes activity [4]. However, the iron overload or toxicity could lead to oxidative stress, thereby detrimental viral mutations [36]. Also, the risk of pneumonia and malaria doubles in children from tropical areas due to iron overload [4]. Therefore the recommended intake of iron in children is necessary to fight with the COVID-19 virus.

2. Selenium

Selenium is one of the essential trace minerals which boost the immune response against the virus. Selenium deficiency causes deleterious influence on both the immune response and viral pathogens. It leads to oxidative stress in the host, which thereby alters the genome of the virus to such extent that a benign or mild virus could develop virulent effects in the host [37]. Besides the deficiency may lead to mutations in RNA viruses which may lead to deleterious virulence [38]. Looking into the immune protective behavior of selenium it must be included in the diets of children to boost immunity against the COVID-19 virus.

3. Zinc

Zinc is another micronutrient associated with the development of innate and adaptive immunity [39]. Studies have shown that the intake of zinc supplements by the zinc-deficient children could lower the measles linked morbidities and mortalities brought about by infections of the lower respiratory tract [40]. Moreover, zinc together with zinc-ionophore (pyrithione) is known to hamper the replication of RNA viruses. Besides at lower concentration zinc and pyrithione could hinder the replication of SARS-CoV [41]. The inclusion of zinc in the diet would not only have an impact on respiratory and diarrheal symptoms of the COVID-19 virus, while it will also affect the immune response and COVID-19 virus itself [2]. World Health Organization recommendations suggest daily intake of10mg of zinc in infants aged below six months while 20 mg zinc intake per day for older children [11].

4. Vitamin D

Vitamin D is a fat-soluble nutrient that plays the dual role of vitamin and a hormone to regulate calcium metabolism in the body. However, it plays a main role in bone formation and maintaining homeostasis of bones but it also helps in modulating both adaptive and innate immune responses [42]. Various studies have shown the therapeutic roles of vitamin D in boosting immunity against coronavirus. According to a study by Bergman and others showed that the chances of influenza and COVID-19 get lower due to the linked inflammatory status and antimicrobial peptides and through regulation of the adaptive type immunity. This intent was authenticated through a series of reviews on randomized control trials based on the administration of vitamin D resulting in an efficient plan [43]. Remarkably, reports have shown that the vitamin D or calcitriol have marked impact on the Angiotensin-converting enzyme-2 (ACE-2)/ Angiotensin 1-7 or Mas Receptor axis leading to higher expression of ACE-2(Cui *et al*., 2019), which is the host cell receptor accountable to mediate the infection caused by SARS CoV-2. However report by a scientist Dr. Holick, showed that elderly people who have limited exposure to sunlight and those who are mostly confined to home or institutionalized have a higher risk of vitamin D deficiency; therefore, the needs of the vitamin are also high[44]. As per the European Calcified Tissue Society, the serum levels of 25 Hydroxy Vitamin D lower than 30 nmol/L is considered as severe vitamin D deficiency, which is a problem of public health concern [45]. Therefore dietary intake of vitamin D from animal sources such as oily fish, salmon, chicken, etc. along with sun exposure is necessary to maintain the body levels of the vitamin as well as for treatment of COVID-19.

5. Vitamin E

It is a fat-soluble vitamin mostly exists in eight forms (α, β, γ, Δ tocopherol and α, β, γ, Δ tocotrienols), out of which α-tocopherol is the biologically active form. Vitamin E is known as a fat-soluble antioxidant that hinders the formation of reactive oxygen species by binding to free radicals during the oxidation of fat [46]. Vitamin E exhibits the immune-boosting properties by acting as an oxygen scavenger to reduce the oxidative stress and also it show anti-inflammatory properties [47]. A study done on mice showed that the deficiency of vitamin E could exaggerate the myocardial injury of coxsackievirus B_3 infection, which is a type of RNA virus [48]. Another study revealed that the low status of vitamin E and D in calves led to bovine coronavirus infections [49]. Therefore the inclusion of vitamin E in the diet may express the immune-enhancing effects.

6. Vitamin C

Ascorbic acid, is a water-soluble vitamin which is one of the powerful antioxidants. Vitamin C acts as a cofactor and is involved in the synthesis of collagen in connective tissues, carnitine biosynthesis, iron absorption, healing of wounds, and repair of body tissues. A study reported the effect of vitamin C in enhancing the body's immunity and safeguarding from the infection caused due to SARS coronavirus [50]. Vitamin C also exhibits anti-allergic properties; it protects against the signs of a viral infection such as sneezing, running nose, swollen sinuses, etc. [51]. Vitamin C also helps in maturation of T lymphocyte cells, which helps safeguard the body against pathogens [4].

General dietary guideline for malnourished patients with risk of COVID-19

- Take an adequately nutritious diet enriched with whole grains, fruits, vegetables, pulses, and an adequate amount of water.
- Eat fruits like Papaya, Guava, Orange, Amla (Indian gooseberry), and Kiwi that are rich in vitamin C.
- Include immunity-boosting herbs such as garlic, black cumin, ginseng, etc. in your diet.
- Enrich your food with omega-3 fatty acids commonly found in flax seeds, walnut, edamame, chia seeds, fish/seafood, etc.
- Eat a colorful diet balanced with foods from both plant sources like vegetables and animal sources like milk, egg, lean meat, etc.
- Try to eat warm and freshly prepared foods.
- In the case of malnourished patients, oral nutritional supplements, along with the proper dietary intake, are useful. In patients with dysphagia, the consistency of diet could be modified along with the intake of oral nutritional supplements [24].
- Intravenous administration should be provided to patients who face difficulty in oral intake [52].

Conclusion

Food can give employment to people and the survival of every living creature on this planet. Food is a matter of survival in extreme circumstances. However, in regular times, access to nutritious food is equally essential. Pandemic or not, access to affordable and safe food should not be uncertainty for any section of the society. An approach towards not only providing nutritional security but also create new jobs, save fiscal resources, support economic growth and promote sustainable diets and agricultural opportunities thus bringing an end to the commotion and terror of the virus. Food security and safety has become everyone's business; we need a transformation from the grass-root level, i.e., from farm to fork. Due to this COVID-19 pandemic, the global burden of malnutrition has been worsening. Physical access to food and economic commotion is the major setback caused due to pandemic. Hence there is a need to pave the pathway for better sowing, harvesting, processing, storage, transit policies, consumer behavior, and consumer consciousness. The problem needs an affordable solution for everyone, as food price and income is a huge constraint. This pandemic has made people realize the healing potential of food, and the importance of making healthier food choices, what we eat and

how we eat, in order to overcome this pandemic. Sustainability shall be the fashion statement for all the food processing fraternity all over the world.

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