

Review Article

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COVID-19: Nutrition to Boost Immune System to Fight Infection

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ABSTRACT

The immunity and immune system functions to fight against infections are significantly impacted by inappropriate food and nutrition. Long term malnutrition is universally considered as the leading cause of immune system deficiency. A substantial proportion of the global population does not meet the recommended daily intake of nutrients. The COVID-19 pandemic has focused attention on the role of the immune system, with health scientists and nutritionists urging people to take supplements and/or eat particular foods (nutrients) to super-charge their immune systems. The immune system is the most complex system of human body. This system is made up of a complex network of structural and functional units like cells, molecules, tissues and organs all working together to safeguard the body as a whole. This precise review provides a chance to go through the efficacy, efficiency and scientific significance of nutritional components and relevant food (especially fruits and vegetables). This will help you keep appropriate food items in your daily meals so that you can get a progressive increment in your body's defence mechanisms and immunity to fight appropriately against COVID-19. This will also help to decrease your risk for catching the viral infection and/or reducing the chances of having complications from COVID-19.

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Received: May 04, 2020; **Accepted:** May 08, 2020; **Published:** May 13, 2020

Keywords: COVID-19, Food, Nutrition, Immunity, Infection

Food, nutrition and immunity

Since birth to the old age, an appropriately good food and nutrition support the body throughout the life. A balanced diet, including all food and nutritional groups, support an effective immune system and may provide protection against infections, cancers and other diseases. The immunity and immune system functions to fight against infections are significantly impacted by inappropriate food and nutrition. Long term malnutrition is universally considered as the leading cause of immune system deficiency. A substantial proportion of the global population does not meet the recommended daily intake of nutrients. The COVID-19 pandemic has focused attention on the role of the immune system, with health scientists and nutritionists urging people to take supplements and/or eat particular foods (nutrients) to super-charge their immune systems. The immune system is the most complex system of human body. This system is made up of a complex network of structural and functional units like cells, molecules, tissues and organs all working together to safeguard the body as a whole. Immunity is a complex and redundant system that requires all nutrients for proper functioning [1]. This complexity means that it cannot be modified acutely by a specific nutritional intervention. Instead of, adhering to a healthy diet provides continuous support to the immune system and may even defer the process of immune-senescence i.e., the natural gradual deterioration of the immune system as we get older. The appropriate nutrition and food must include the recommended

amounts of nutrients (both micro and macro) as well as the normal microbial flora of gut to mediate the immunological effects. The immune system and functions modulation based on nutrition has implications, not only in the clinical setting, but this also plays a key role in healthy populations to reduce or delay the onset of immune-mediated chronic diseases [2]. To fighting off the foreign cells, including bacteria and viruses, the immune systems perform an outstanding job to protect us against infections (illness). In this defence mechanism, a number of factors play their role, such as age, which determine how much resistant the human defence system will become. That is the reason why, upon a global health pandemic outbreak like COVID-19, we need to feel more anxious than normal about staying protected, defended, strong and healthy. It is accepted that unless an appropriate remedy to this infection, a vaccine, is available, "our immune systems will need to adapt unaided to COVID-19 [3].

What food and nutrition supplements can boost the immunity against COVID-19?

At the outbreak of COVID-19 pandemic the British Dietetic Association recently published a statement; "Simply put, you cannot boost your immune system through diet, and no specific food or supplement will prevent you catching COVID-19 viral infection. Good hygiene practice remains the best means of avoiding infection [4]." If you smoke, you are at an increased risk of getting infection leading to suffering from severe complications of the infections. [5]. There shouldn't be more reasons why not to smoke, but a time like COVID-19 pandemic highlights the

importance even more than before. When it comes to a stressful time, like this COVID-19 spread, people often start turning to alcohol consumption as a coping mechanism. Everyday nature walks, along with mindfulness exercises and activities are likely healthier ways of coping and managing the stress while meditation. We actually need to do what we can to get through stressful and unprecedented hard times. Recent and relevant studies have shown a significant relationship between chronic heavy alcohol consumption and increased susceptibility to infections. Possibly most applicable to this discussion regarding COVID-19, many of similar studies and research showed an increased risk among heavy drinkers of acute respiratory distress syndrome (ARDS), the lung complication responsible for most of the COVID-19 related deaths [6]. The normal and efficient operations of human immune system are based on variety of different food, nutrients and their components. This is the reason why maintaining a balanced and healthy diet and food is the best possible way to support the appropriate, effective and robust immunity and immune system functions. Important nutrients and food for effective immune function and suggested through available scientific literature to boost the immunity fighting against COVID-19, are:

Vitamin A (Carrot, Collard, Red Pepper, Turnip, Kale, Sweet Potato)

An important micronutrient, vitamin A has been considered as a crucial dietary component to maintain proper vision, promote progressive growth and development, and to protect epithelium and mucus integrity in human body. Vitamin A is also known as an anti-inflammatory substance because of its critical role in enhancing immune function. The normal development of human immune system also requires appropriate amounts of vitamin A. It also plays regulatory role in humoral and cellular immune responses as well as overall processes. Vitamin A has been established as a therapeutic agent in the treatment of a number of bacterial and infections and their manifestations [7].

Vitamin B₆ (Spinach, Green Peas, Banana, Chickpeas, Avocado)

Vitamin B₆ is vital to catalyse a number of biochemical reactions in the immune system. Studies conducted on experimental animals related to the development of immune processes in B vitamin deficiency revealed significant participation of vitamin B₆ nutritional factors in the production of circulating antibodies to a variety of antigens and the manifestation of delayed hypersensitivity reactions, including the rejection of tissue transplants [8]. Slightly higher than normal recommended doses of vitamin B₆ can be compensated for the lack of responsiveness and further increase immune response in critically ill patients. It has been established through scientific and clinical studies that vitamin B₆ supplementation increases the immune system response and functionality in critically ill patients suffering from bacterial and viral infections, and this may have equal applications on COVID-19 patients especially those who are critically ill [9].

Vitamin B₁₂ (Sources: Fortified Cereals, Fortified Yeast, Salmon, Tuna, Non-dairy milk)

Vitamin B₁₂ supports many different systems and is a cofactor in the regular biochemical function of many proteins and lipids. Vitamin B₁₂ contributes to the normal function of the red blood cell development and normal DNA maintenance required to keep our body in top shape. It has been suggested that vitamin B₁₂ plays an important role in immune system regulation. Despite the fact but

the details are still obscure, a number of relevant clinical studies found a significant decrease in the absolute number of immune cells cell activity in vitamin B₁₂ deficient patients. Moreover, augmentation of immune cells by vitamin B₁₂ administration was observed even in control subjects. These observations may contribute to our understanding of the potential antiviral effects of vitamin B₁₂ while fighting against COVID-19, and may partly explain the rationale for considering the use of vit.B₁₂ for treating a variety of other immunological, neurological, and oncological disorders [10].

Vitamin C

(Sources: Citrus, Orange, Lemon, Plum, Blackcurrant, Chilli, Parsley, Spinach, Kiwi)

For a long time, Vitamin C has been considered as a preventive agent against common cold. Along with other benefits, vitamin C is also involved to help maintain healthy skin which provides a first line of defence to bacteria, virus and other harmful invaders. Also, through scientific literature, it is shown that it may improve the function of those white blood cells which significantly fight against infection [11]. Although it's not very clear about vitamin C supplementation whether it is beneficial to best prepare human immune system functions for fighting against COVID-19, for most of us there's no harm in taking improved doses up to 2000 mg/day. For those who are at high risk due to underlying medical conditions and smokers, it's definitely worth considering. Since vitamin C is a water-soluble vitamin, your body will readily excrete whatever you don't need into your urine. In addition, there is an inconsistent amount of evidence available regarding the potential mortality benefits of vitamin C if taken in high doses in patients with septic conditions, which is the severe type of infections [12]. Scientists and nutritionists in countries suffering from recent COVID-19 outbreak have been looking to see whether extremely high doses of vitamin C can help COVID-19 patients both fight infection and reduce the symptoms of the disease, however, in case of taking plenty of fruits and vegetables in diet, it is suggested to avoid taking vitamin C supplements in bulk otherwise you will be ending up wasting your money.

Vitamin D

(Sources: Cod liver oil, Salmon, Canned tuna, Egg yolk, Mushrooms, Cow's milk)

Vitamin D has been known to play a vital role in human health, as a vitamin as well as an integral component of hormonal functions. There has been a clear indication of vitamin D deficiency implications as far as immune system functions are concerned in recent years. Recent studies suggested an increased susceptibility to infection and a diathesis, in a genetically susceptible host to autoimmunity [13]. Both, adaptive and innate immunity and immune responses can be modulated by vitamin D. Vitamin D deficiency has also been associated with an increase in autoimmunity as well as an increased susceptibility to infection. As immune cells in autoimmune diseases are responsive to the ameliorative effects of vitamin D, the beneficial effects of supplementing vitamin D deficient individuals with autoimmune disease may extend beyond the effects on bone and calcium homeostasis [14]. In recent years, people have taken very high doses of Vitamin D with the intention of boosting immunity, however, a recent systematic review found that taking a Vitamin D supplement seemed to have a mild protective effect against respiratory tract infections such as COVID-19 in most people, but provided much greater protection in those who were very deficient in Vitamin D [15].

Folic acid

(Sources: Garbanzo Beans, Liver, Sprouts, Lentils, Spinach, Asparagus, Avocado)

An insufficient micronutrient intake has been found to impact some significant changes in regulation of the immune system and functions. Scientific literature and evidence suggest that the immune system and functions are balanced in the presence of sufficient amount of folic acid. The production of nucleic acids (DNA and RAN), synthesis of protein, inhibition of immune cells and their activities are found to be negatively impacted by inadequate levels of folic acid leading to a drastically altered immune responses [16]. Folic acid is beneficial to human immune system. According to scientific and research reports negative effects were observed on human immune response due to folic acid deficiency. It has been found to help in the process of DNA and RNA productions as it works as co-factor in many biochemical reactions involved in those sensitive processes. These nuclear materials are essential for the growth and production of cells such as white blood cells that are integral to your immune system [17].

Copper

(Sources: Mushrooms, Spirulina, Nuts, Seeds, Lobster, Green Leafy Vegetables, Dark Chocolate)

Copper is an essential nutrient for humans, although its deficiency is rare. Copper deficient animals are more susceptible to parasitic, bacterial, and viral infection. Studies shown that the patients with a copper deficiency genetic disease (Menkes syndrome) which is marked by copper malabsorption generally die from infectious bronchopneumonia [18]. Sufficient amount of copper is required by the immune to perform several important functions, without a properly known direct mechanism of action. Research models and cells in culture have been used to assess copper's role in the immune response. Recent research showed that during copper deficiency, interleukin 2 has been found to be reduced leading to a significant reduction in the T cell proliferation mechanism. These researches have been extended to show the proliferative response and interleukin concentrations are reduced even in case of a marginal deficiency. This has been observed in cases when common indexes of copper are not affected by the diet. A severe copper deficiency has also been observed to reduce the number of neutrophils in human peripheral blood. In learning the functions of copper or assessing copper status, the identity of copper-binding proteins in this cell type may be useful. As neutrophils are short-lived and homogeneous cell populations, they are predicted to be an effective and valuable tool for assessing nutrient status in human populations [19].

Selenium

(Sources: Brazil Nuts, Tuna, Oysters, Chicken Breast, Whole Wheat Pasta, Mushrooms)

Selenium (Se) is an essential component of antioxidant enzyme system that plays an important role in removing hydrogen peroxide and organic hydroperoxides. Its deficiency Se can induce a state of oxidative stress in the body, which can affect immune system cells in a number of ways. In oxidative stress, oxygen free radicals damage on the order of 10,000 DNA bases per cell per day, of which a small percentage are not repaired. Membrane integrity of cells becomes impaired due to oxygen free radical-mediated lipid peroxidation, leading to the suppression or loss of immunity through its cellular function [18].

Iron

(Sources: Spinach, Liver, Legumes, Red Meat, Pumpkin Seeds, Quinoa, Turkey, Broccoli)

As suggested by available scientific literature for the normal development the human immune system iron is an essential element. The capacity of an effective immune system and adequate immune response are significantly impacted by iron deficiency. The role of iron in immunity is crucial for the proliferation and maturation of immune cells, particularly lymphocytes, associated with the generation of a specific response to infection. The body has the capacity to reduce the iron availability to be consumed by infectious elements by proteins such as transferrin and lactoferrin [20]. Also, iron is essential for the proliferation of bacterial and viral parasites. The development of infections and the invasion of tumoral cells could be potentially facilitated by excess iron. The immune system has bacteriostatic mechanisms that reduce the availability of the metal, interfering with bacterial growth. In the production of bacteriostatic cells and mechanisms, the iron is used as an integral and intermediary element [21].

Zinc

(Sources: Raisin Bran, Baked Beans, Cashews, Chickpeas, Oysters)

The white blood cells response to infections has been categorised by a mineral Zinc. That is the reason why, people who are deficient in zinc are more susceptible to cold, flu, and other viral infections. Whether it could have a similar effect on COVID-19 isn't yet known, however, earlier studies including clinical trials found that zinc supplementation reduced the length of the common cold by an average of 33% [22]. Zinc has been established as an essential trace element which significantly influences the growth and affects the development and integrity of human immune system. The exact molecular mechanisms explaining the accurate action of zinc on human immune function are yet to be established through scientific researches. Zinc has a broad impact on key immunity mediators, for example various peptides, cytokines and number of enzymes, explaining the paramount importance of zinc's status on the regulation of lymphoid cell activation, proliferation and apoptosis. Current and future researches focussing on the immunological status of zinc deficiency will lead to public health interventions with nutritional doses of zinc supplements to prevent alteration of the immune system and improve resistance to infections, especially at risk populations [23]. Not a single food is recommended over another and eating a variety of foods will help to maintain a balanced and healthy diet. These nutrients have an important property of immune-protection, i.e., antioxidant capacity. If these nutrients are taken in excessive amounts, this antioxidant property is likely to be lost.

How to protect and boost the immune system?

The infection prevention recommendations are the most suitable first line of defence in supporting the immune system against infection, including COVID-19:

- Maintain a healthy weight
- Keep yourself physically active
- Maximise eating whole grains, fruits, vegetables and beans
- Minimise eating fast foods
- Minimise eating red and processed meat
- Minimise sugar sweetened drinks, packed juices
- Minimise alcohol consumption
- Don't rely on supplements
- Breastfeed your baby (if you can)

For protection against COVID-19, following the hygiene rules is key. It is also important to get enough sleep, manage stress, balance work and life and avoid smoking.

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