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# Role of Nutrition in Prevention and Prognosis of the COVID-19 Infection - A Review

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**Abstract:** ***Coronavirus disease 2019 (COVID-19), a disease caused by the novel coronavirus, has become a major global human threat that has disrupted people's lives all over the world. Existing evidence suggests that nutrition may have a profound effect on the immune system and susceptibility to this disease. Some nutrients have been reported to have an important role in the prevention and management of COVID-19 infection. The nutritional status of the host may influence the clinical outcomes of COVID-19. Correction of micronutrient deficiencies in patients with established COVID-19 infection may contribute to improving the immune response to the infection in those who are at highest risk. Accordingly, maintaining a healthy immune system is critical at all times - more so during the COVID-19 outbreak. Hence, improving the quality of diet in individuals vulnerable to COVID-19 might reduce their risk of developing complications. It is hypothesized that nutrition may play an important role in protecting individuals from contracting this disease or leading to positive outcomes and quicker recoveries of the already infected patients. This review is a narrative one and will examine the available evidence on the association between nutrition and the COVID-19 infection.***

**Keywords:** Nutrition, Nutritional status, COVID-19 infection, Immune function, Micronutrients

## 1. Introduction

Coronavirus disease 2019 (COVID-19) is the infectious disease caused by the most recently discovered strain of coronavirus called SARS-CoV-2. This new virus is linked to the same family of viruses as Severe Acute Respiratory Syndrome (SARS) and some types of common cold [1]. COVID-19 is now a pandemic affecting many countries globally and has been declared by the World Health Organization (WHO) as a global public health emergency [2]. Corona Virus is a pathogen that mainly targets the human respiratory system [3].

Adequate nutrition may play an important role in protecting against an excessive inflammatory response to SARS-Cov-2 infection, preventing the progress of the infection to severe diseases or helping in recovering sooner even during COVID-19. The nutrients present in the diet taken may also determine the gut microbial composition and consequently help improve the immune responses in the body [3]. Some nutrients have been reported to play an important role in the prevention and treatment of COVID-19 infection. The most important among them are vitamins A, D, and E, the minerals zinc and selenium, fiber, and essential fatty acids, as they promote an effect on the immune system [4]. It has been reported that the nutritional status of patients and the general population may be particularly at risk during the current COVID-19 outbreak [5]. Hence, improving the quality of diet in individuals vulnerable to COVID-19 might reduce their risk of developing complications [6]. The role of nutrition in protecting individuals from contracting this disease or leading to positive outcomes and quicker recoveries of the already infected patients needs to be studied. This review is a narrative one and will examine the available evidence on the association between nutrition and the COVID-19 infection.

Searches were made in PubMed.gov and scholar.google.com for publications pertaining to COVID-19 and nutrition with respect to immune response, micronutrients and dietary recommendations.

## 2. The link between Nutrition and Immunity

Therapeutic strategies against COVID-19 are likely to be focused on either enhancing the human immune system to minimize the intensity of SARS-CoV-2 infection, or developing specific virucidal agents against SARS-CoV-2.Existing evidence suggests that nutrition may have a profound effect on the immune system and disease susceptibility. The nutritional status of the host has been reported to influence the clinical outcomes of COVID-19. Therefore, maintaining a healthy immune system is critical at all times – more so during the COVID-19 outbreak. Lower Respiratory tract infection is a major cause of morbidity and mortality and is the leading cause of infection related deaths worldwide [7].

A bidirectional relationship exists between nutrition and infection, whereby poor nutritional status predisposes a person to infection and where infection is exacerbated by a poor nutritional status [8]. Vitamins and minerals have been reported to play a role in neutralizing the effects of harmful oxidative agents that have the potential to damage cells. Several vitamins, including vitamins A, $B_6$, $B_{12}$, C, D, E, and folate; and trace elements, including zinc, iron, selenium, magnesium, and copper, play important and complementary roles in supporting both the innate and adaptive immune systems [9]. Deficiency or suboptimal status of these nutrients suppresses immune function and increases the susceptibility to infection, creating a vicious cycle of deficiency and disease.

Micronutrients play a crucial role in mediating inflammatory responses and such effects may be enhanced through correction of micronutrient deficiencies if any. It has been reported that many of those who were at the highest risk during the COVID-19 pandemic were also among the populations which had micronutrient deficiencies and poorer overall nutrition. Correction of micronutrient deficiencies in patients with established COVID-19 infection may contribute to improving the immune response to the infection in those who are at highest risk [10]. Nutritional deficiencies of energy, protein, and specific micronutrients have been associated with depressed immune function and increased susceptibility to infection. An adequate intake of iron, zinc, and vitamins A, E, $B_6$, and $B_{12}$ is vital for the maintenance of immune function [11]. Therefore, the key to maintaining an effective immune system is to maintain an adequate diet and prevent deficiencies of the nutrients that play an essential role in immune cell triggering, interaction, differentiation, or functional expression.

## 3. The protective role of specific nutrients

Nutrition might not be directly linked with the spread of the disease however it is hypothesized that well-nourished people have a stronger immune system and have better chances of not contracting the infection or fighting against it. Although there is substantial evidence that nutrients play a vital role in the defense against infectious diseases and the regulation of inflammation; little is known with regards to COVID-19.

Impairment of micronutrient balance adversely affects the immune system and increases host susceptibility to various bacterial and viral microorganisms. The fat-soluble vitamins A, E and D; C & B vitamins, and minerals including zinc, selenium, iron and copper, phytonutrients, amino acids and fatty acids are necessary for optimal immune function (to prevent establishment of viral infection) and immune regulation. These nutrients are critical for the functioning of the T cells, B cells, killer cells, macrophages, and neutrophils/ granulocytes that are involved in the destruction and elimination of infectious microbes. In addition, there are many other immune related functions that are carried out by these nutrients and phytonutrients [12]. Inadequate nutrient intake has been reported to lead to a decrease in resistance to infections and an increase in disease burden. Clinical data reveals that vitamins, including vitamins A, $B_6$, $B_{12}$, C, D, E, and folate; trace elements, including zinc, iron, selenium, magnesium, and copper; and the omega-3 fatty acids eicosapentaenoic acid and docosahexaenoic acid play important and complementary roles in supporting the immune system [13].

Vitamin A has a role in mucosal epithelium (skin and mucous membrane) integrity, which is compromised in vitamin A deficiency and leads to increased susceptibility to infection via the eyes, respiratory and gastrointestinal tract [14]. Vitamin A deficiency therefore may contribute to increased vulnerability to infections including COVID-19.
Low vitamin D status is associated with increased susceptibility to infectious disease; notably, upper respiratory tract infections. A role for vitamin D in the response to COVID-19 infection could be twofold. First, vitamin D supports production of antimicrobial peptides in the respiratory epithelium, thus making infection with the virus and development of COVID-19 symptoms less likely. Second, vitamin D might help to reduce the inflammatory response to infection with SARS-CoV-2 [15]. The fact that the first outbreak of COVID-19 occurred in the winter season, usually during which the 25-hydroxyvitamin D (25(OH)D) concentrations are lowest, supports the protective role of vitamin D in reducing the risk of COVID-19 infection [16]. Although the natural source of vitamin D is from sunlight exposure, some dietary sources can provide a certain amount of vitamin D that includes fortified foods and milk. However, for people at risk of contracting the infection, the aim should be to increase the concentrations of 25(OH)D above 40–60 ng/ml (100–150 nmol/l) by considering taking 10,000 IU/d of vitamin D3 for a few weeks to rapidly raise 25(OH)D concentrations, followed by 5000 IU/d. For treatment of people who are already infected with COVID-19, higher vitamin D3 doses may be needed [17]. However, large population studies and randomized controlled trials will be needed to evaluate these recommendations and their precise effects in relation to the COVID-19 infection.

Vitamin C is an effective antioxidant and increases the epithelial barrier function and promotes oxygen radical scavenging activity of the skin. Vitamin C deficiency has also been reported to impair immunity and increase susceptibility to infections [10]. A moderate amount of vitamin C supplementation has been suggested as a method to prevent COVID-19 infection [16].

Zinc deficiency can interfere with host-defense systems and increase the susceptibility to various viral and bacterial infections. Numerous Randomized Control Trials have demonstrated that supplementation of moderate zinc doses in healthy elderly individuals improves several aspects of immune functioning and may reduce incidence of infections and even overall mortality [18]. Zinc has antiviral effects and improves immune responses and suppresses viral replication. Hence, maintaining adequate zinc balance is important to protect from microorganisms, including viral infections. The consumption of 40 mg zinc per day has been recommended to be beneficial against the SARS-CoV-2 infection, likely by enhancing the host resistance against the viral infection [19].

Correction of established micronutrient deficiencies, or in some cases assumed suboptimal status, has the potential to help support immune function and mitigate the risk of infection. Treatment of micronutrient deficiencies in established COVID-19 infection may also contribute to supporting immune response to infection in those at highest risk.

## 4. High risk groups for COVID-19 infection

The host metabolic status, as influenced by age, sex, medical conditions, and lifestyle factors determine the clinical severity of COVID-19 [20].Well-nourished individuals are less likely to contract infections including SARS-CoV-2 and this statement is corroborated by the results of a large observational study which found that complications, length

of stay and mortality were significantly higher in untreated, nutritionally at-risk in-patients than in in-patients who were not at risk [21], indicating that nutrition is both preventive and also contributes to a positive outcome. The COVID-19 infection appears to occur with increased severity among those with higher BMI, the elderly and subjects with comorbid conditions, who are likely to have impaired nutrition status, thus suggesting a possible link between the nutritional status of the host and the clinical outcomes of COVID-19 [7].

Ageing is often associated with a deterioration of the immune functioning and the elderly are often more prone to infections, including respiratory diseases than young individuals [6]. Additionally, the mortality rate from COVID-19 is reported to be higher in older adults in clinical settings [22]. Clinical or subclinical micronutrient deficiency is also common in older adults, which contributes to several age-related diseases and decreased immune function. This is probably the consequence of low appetite which is often seen in the elderly and the lack of a diversified diet. Higher levels of micronutrient deficiencies have been reported to exist in older adults which may have adverse outcomes in clinical settings [23]. This is due to a variety of factors influencing low dietary intake and nutrient absorption, together with increased requirements to compensate for deficits in cellular function and the stress response associated with ageing. Additionally, ageing is associated with reduced antioxidant production and vitamin D synthesis in the skin. Elderly people are also at higher risk of vitamin C deficiency, and if deficient are likely to have a compromised immune system, and may be prone to contract infections and develop sepsis. Supplementation has been reported to reduce incidence and duration of respiratory tract infection and severity of pneumonia in hospitalised older adults[10].Complete nutritional assessment and proper management are, therefore, essential to determine the risk of infection, the clinical course, and the outcome of COVID-19 in older adults.

Apart from the elderly, pregnant women, lactating women and children may also be at high risk due to their increased nutritional requirements and susceptibility to infections. Women and children who are already malnourished are doubly susceptible to acquiring COVID-19 infection because malnutrition can weaken the immune system. It has been reported that women and children face a greater risk of malnutrition during the pandemic which may eventually lead to increased morbidity and mortality [24]. The lockdown imposed in various countries has resulted in a decrease in household incomes leading to reduced availability and access to food. The predictable outcomes of such situations might affect the immune function, increase the susceptibility to infections and lead to a high incidence of wasting and stunting among children. Therefore, it is important to ensure adequate nutrition among women and children in resource-constrained settings by developing and implementing mitigation strategies to reach out to those most affected by the crisis and initiate an effective nutrition response.

Children and adults with underlying comorbidities particularly non communicable diseases like diabetes, hypertension and overweight/obesity are particularly vulnerable to serious illness and death from COVID-19 [25]. The presence of existing co-morbidities is associated with poorer clinical outcomes in patients with COVID-19 [16]. Dietary management of pre-existing diseases has been suggested as a strategy to minimize the potential risk of SARS-CoV-2 infection in patients with comorbid conditions. Nutritional care may therefore have to be implemented early to ensure better outcomes in such patients.

## 5. Guidelines for Nutritional intake and Physical activity

The ESPEN (European Society for Clinical Nutrition and Metabolism) guidelines for nutritional management of patients with SARS-CoV-2 infection recommend provision of daily allowances of vitamins and trace elements to malnourished patients at risk for or with COVID-19, aimed at maximizing general anti-infection nutritional defense [26]. It is suggested that energy and protein intakes should be individually adjusted based on nutritional status, physical activity level, disease status and tolerance. Higher protein intakes may be necessary for polymorbid inpatients to prevent weight loss, reduce the risk of complications and improve functional outcome. The guidelines state that subjects with malnutrition may require supplementation with vitamins and minerals. The recommendations underline the need to spend more than 30 minutes on exercise every day or more than one hour every second day to maintain fitness, mental health, muscle mass and thus energy expenditure and body composition [26]. Patients in quarantine should also be advised to continue regular physical activity while taking precautions.

## 6. Conclusion

Nutrition thus appears to be a key determinant of susceptibility to SARS-CoV-2 infection and may also have a significant impact on the clinical outcome in patients who have contracted the infection. A balanced diet that consists of the recommended amounts of macronutrients and micronutrients may be vital in the prevention and treatment of the COVID-19 infection. Although there is considerable evidence that micronutrients play a significant role in preventing infection including SARS-Cov-2, there is no conclusive evidence about the prophylactic or therapeutic role of micronutrient supplements in COVID-19 infection. Patients with comorbidities especially chronic diseases such as diabetes, hypertension, coronary heart disease and cancer, are more prone to SARS-CoV-2 infection and may also experience severe clinical outcomes, therefore it is particularly important to enhance self-resistance in these individuals by providing them with appropriate advice on the composition of an optimal diet. Nutritional advice should also be accompanied with guidelines on physical activity and strengthening exercises to build muscle mass. While more research is needed to establish the precise role of nutrition in the prevention and treatment of COVID-19 infection it is important to emphasize the need to achieve micronutrient adequacy and optimal nutritional status especially in those who are at highest risk.

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