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Review Article

Treatment and Prevention of Viral Infections through Nutrition and Strengthened Immunity: The COVID-19 Pandemic Case Scenario

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Abstract

The cause of the ongoing massive pandemic, the SARS-CoV-2 virus, originated in Wuhan, China and spread rapidly worldwide. The pandemic has helped identify the difficulties associated with devising best practices necessary to augment the immune system to prevent the contraction of viral infections, as well as enhance the process of recovery if an infection does occur. Medical scholars and researchers have been actively assessing dietary aspects that may improve the health of immune systems. It is already well-established that malnourishment can lead to increased oxidative stress and cause inflammation. Such conditions weaken the immune system and make people vulnerable to bacterial and infectious illnesses. In the current scenario, scientists have confirmed that some dietary components can enhance immunity in COVID-19 patients. Empirical evidence suggested that the condition of COVID-19 patients is largely attributable to increased metabolic rates that drain the body's glucose supplies. This highlights the necessity of improving the quality of enteral nutrition provided to COVID-19 patients. Despite being dietarily sensitive, these individuals require regular monitoring and assessments to discern their nutritional deficiencies. In general, the diet should include foodstuffs with anti-inflammatory properties and micronutrients, including polyphenols, carotenoids, vitamin C, vitamin E, etc. Considering nutrition in the overall treatment provided will greatly fortify the immunity of COVID-19 patients and increase the probability of survival.

Key words: COVID-19, inflammation, dietary therapy, oxidative stress, enteral nutrition, immune system

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INTRODUCTION

Food varieties with nutritional promise and dietary supplements are a common preference nowadays owing to their capability of enhancing immunity and helping prevent health issues. Dietary practices may include lifestyle changes, such as the consumption of natural citrus products, increased intake of vitamin C, chicken soup, fruits and vegetables and replacing sugar with honey. Many research studies now provide empirical proof that the human immune system is intricate and relies extensively upon an equilibrium of various elements. Good eating habits must be coupled with healthy living standards and practices as well. For example, individuals should ensure sufficient rest, adequate sleep and low levels of anxiety or stress to strengthen their immunity and thus, improve their ability to resist infections and diseases.

The health of the immune system is critical as it shields the body from microscopic organisms, viral infections, parasitic growth and fungi¹. The immune system performs its job consistently with no breaks. However, a strong attack by pathogens may render the body prone to extreme reactions, such as destruction of specialized cell types and disruption of signalling within and across cells. Once an individual contracts a viral agent, the first response of the body is an increase in the metabolic rate as it tries to maintain regulatory systems, which requires energy. Calder¹ recommended that some nutrients, for example, vitamins A, C, D, E and mineral supplements, including zinc, iron and copper are very important to the immune system as they provide support against pathogenic attacks. Similarly, vitamin E has been demonstrated to have a protective effect against oxidative stress² while extracts from fruits are helpful to improve plasma lipid profiles and removed oxidative stress as well^{3,4}. It has similarly been extensively reviewed in the literature that suitable diets and exercises are necessary for people suffering from metabolic disorders or conditions, such as diabetes, obesity, kidney conditions and even psychological abnormalities^{5,6}. It is essential to maintain a sufficient intake of supplements to bolster the immune system, even if such a practice is started after contracting an infection.

Iddir *et al.*⁷ assessed many potential ways of improving the reaction of the immune system to diseases and infections, particularly by introducing changes in diet. Their study considered large-scale factors that were involved in the spread of COVID-19 to the point of becoming a pandemic. The outbreak and spread of the SARS-CoV-2, which is the virus that caused COVID-19, were majorly assessed by reviewing the observations of medical workers. Among the major challenges

faced by medical professionals, while providing treatment to COVID-19 patients, was the inability of affected individuals to boost their immune systems. As per Iddir *et al.*⁷, there were increased risks of further infection in people with low protein content. The authors asserted that an optimal nutritional status was critical in modulating oxidative stress and inflammation that, in turn, was a major factor influencing the wellbeing of the immune system. Based on their findings, they recommended vitamins, polyphenols, carotenoids and omega-3 fatty acids to be included as dietary components in everyday life. Compounds present in fibrous foodstuffs are often capable of relieving oxidative stress and of maintaining homeostasis before and even during the infection. Most importantly, Iddir *et al.*⁷ highlighted the need to include glutamine in dietary supplements of people, who are in danger of contracting COVID-19. Glutamine is established to be exceptionally powerful in enhancing the expression of genes involved in the strengthening of the immune system. These studies indicate that, in general, food containing fibrous supplements, particularly from plants, have many essential nutrients that are beneficial to the body due to their anti-inflammatory properties. This review presents foundational information on the relationship of good nutritional intake with the immune system and provides recommendations that can help readers improve this relationship.

Relationship between the immune system and good nutrition

Importance of lipids in boosting the immune system:

Harbige⁸ investigated the significance of lipids in boosting the body's immune system. They asserted that fatty acids alter immune responses by influencing connections between cellular lipids and nuclear receptor cells. Radzikowska *et al.*⁹ also reported that fatty acids are integral for the maintenance of homeostasis in the T-cells, nephrotic and epithelial cells. However, excessive consumption of fatty acids can be detrimental to health. According to Calder¹, an imbalance in the intake of both saturated and unsaturated fatty content can lead to terminal implications on the immune system. They can trigger allergies, auto-immune disorders and other metabolic conditions. Therefore, the goal of a balanced diet should be to consume omega-3 and omega-6 proportionally to strengthen the immune system's response to any infection¹⁰. Notably, anti-inflammatory food supplements help improve the immune system. Siegers *et al.*¹¹ reported that taking diets excessively rich in lipids is a major reason for the development of respiratory complications and for being vulnerable to influenza. Furthermore, research on mice has affirmed that

consumption of lipid-rich diets regularly may cause reduced efficacy of influenza vaccine. This may also lead to the reduction of antibody responses, harnessed by macrophage dysfunction.

Role of diets rich in carbohydrates and fibres in strengthening the immune response:

Diets rich in starch and fibre plays an integral role in reinforcing the immune system. Dietary fibres protect body cells from developing inflammation. Stephen *et al.*¹² reported that whole grains can help reduce the chances of acquiring systemic and gut inflammation. Even a small increase in the amounts of fibre eaten per day may significantly improve the reactions of the immune system and decrease the chances of infections aggravating. Likewise, Ma *et al.*¹³ confirmed that consumption of whole grains regularly may lessen the danger of developing obesity or cancer. According to Calder¹, intake of dietary fibre is positively related to a decrease in deaths attributed to respiratory and preventable infectious illnesses in senior citizens in the United States. Similar Kan *et al.*¹⁴ asserted that increased intake of dietary fibre decreases the probability of obstructive pulmonary infections. Different types of dietary filaments can also ensure the well-being of the gut. One way that fibres positively influence health is by strengthening the gut microbiota, which is essential for the maintenance of mucosal integrity. Most importantly, the microbiota is essential to keep the body prepared against viral attacks¹⁵. Budden *et al.*¹⁶ specifically investigated the interplay between gut microbiota and illnesses affecting the respiratory system. They reviewed extensive evidence of intestinal microbiota protecting against flu.

Role of micronutrients in strengthening immunity and reducing inflammation:

Micronutrients have a critical role in fortifying the immune system and in decreasing inflammation¹⁷. Examples of micronutrients include minerals and minor components that are characterized as fundamental to biochemical pathways. A decrease in the degree of micro-dietary supplements may result in serious deficiencies, such as those of essential vitamins. For example, deficiency of vitamin A increases the likelihood of contracting skin diseases. According to Huang *et al.*¹⁸, vitamin A plays an important part in stratification and keratinization, as well as in building a wall of defence against diseases. Moreover, it aids the body in forming a healthy mucus layer due to which many clinical proofs associate it with enhanced protection and resistance against microorganisms. Similarly, vitamin D is crucial to fortifying the immune system. This nutrient can be obtained

in diverse types of dinners, such as fish, milk, eggs and mushrooms. Skin naturally creates vitamin D on exposure to UV light. A recent study by Li *et al.*¹⁹ stated that vitamin D can prevent people against SARS-CoV-2 as well. To put it all together, Ma *et al.*¹³ proposed that deficiencies of vitamin A and D, as well as other micronutrients, are largely reported in nations and parts of the world that suffer from low meat and protein availability.

Increase in COVID-19 cases is attributable to change in diet:

The rising cases of COVID-19 require an adjustment in dietary practices to ensure that immune systems of populations are bolstered globally so that such a calamity may not arise again. Individuals, who contracted this virus, require a unique diet to improve the probability of positive treatment outcomes. Chapple *et al.*²⁰ reported that infection with SARS-CoV-2 leads to a higher-than-normal metabolic rate, which results in increased consumption of glucose in the body. A commonly reported symptom in COVID-19 patients is the loss of appetite. Other health issues aggravate during the recovery stages and may change into critical illness if a good diet is not maintained. This highlights the importance of identifying all possible deficiencies in an individual and develop treatment interventions accordingly.

For the future, Stachowska *et al.*²¹ highlighted that further outbreaks and their spread can be prevented maximally only if a wholesome preventative strategy that includes dietary considerations is developed. This would be effective in fully ensuring the recovery of patients and preventing further infections. Such speculations for the future are reinforced by evidence that patients, who underwent prolonged stays in intensive care units, suffered from malnutrition. On the contrary, the implementation of diets rich in calories and proteins were observed to play an integral role in enhancing positive treatment outcomes in patients. Stachowska *et al.*²¹ asserted that patients have to ensure that their eating regimes utilize probiotics so that they can host a healthy microbiome.

Reduced oxidative stress among COVID-19 patients:

Various research studies prove that it is necessary to lessen oxidative pressure among COVID-19 patients. Ferrie *et al.*²² suggest introducing fish fats as part of the nutritional program for these individuals. Liquid therapeutics has been proposed to be an ideal approach to deal with the loss of appetite and fever as well. Singer *et al.*²³ declared the necessity of ensuring that all gastric systems are accessible and open in patients in need of post-pyloric feeding. This is proposed because of the need to protect the patients' airways from onset of poor

respiration and circulation. Such requirements are standardized for COVID-19 patients.

Recommended dietary practices and nutritional therapies for COVID-19 patients:

Comprehensive and wholesome methodologies for treatment and prevention of COVID-19 discussed in the previous study²³. Their study focused on establishing the importance of ensuring good dietary practices that can help minimize patients' chances of acquiring hypertension during hospitalization. These diets were proposed to be free from allergens and other infectious agents. Another strategy for dealing with COVID-19 was proposed by Azzolino *et al.*²⁴, who recommended that regular tests be performed to determine levels of micronutrients, such as potassium, phosphate and magnesium. Early recognition of any deficiencies enables healthcare providers to develop effective therapeutic programs that are customized to each patient's needs.

A scientific analysis conducted by Reignier *et al.*²⁵ presented a review of nutritional practices that can help COVID-19 patients develop resistance against organ failures. Their study provides evidence that the primary focus for the treatment of COVID-19 needs to consider malnutrition. Food that is high on energy can enhance treatment. Furthermore, food supplements that enhance appetite can strengthen positive treatment outcomes¹⁸. Researchers have established that increasing protein content in the diets of COVID-19 patients can improve their immune systems, thereby reducing mortality rates. This is especially useful in cases, where the individual optimal protein requirements of each patient have been determined so that custom diet plans can be designed according to deficiencies.

In the case of individuals, who have contracted SARS-CoV-2, nutritional customization is essential for quick recuperation. Brugliera *et al.*²⁶ recommended consuming combinations of oligo-components and vitamins at the recuperation stage. Additionally, Zhang and Liu²⁷ promoted the intake of essential and non-essential amino acids to improve the restoration of health, as well as to forestall the probability of relapse²³. If COVID-19 co-occurs with intestinal issues, utilization of probiotics may be required. Furthermore, during hospitalization, the patient must take oral dietary enhancements consistently. In case of dysphagia, an adjustment of the eating regimen may be needed.

Martindale *et al.*²⁸ reviewed the importance of healthy nutritional intake for COVID-19 patients. They recommended administering enteral nutrition to patients admitted to the intensive care units. Similarly, Laviano *et al.*²⁹ asserted that

intake of nutritional supplements may enhance positive patient outcomes. Such treatment procedures must begin between 24 and 36 hrs of admission. Specifically, in the case of COVID-19, it is highly recommended that everyday nutrition be maintained and monitored to keep the immune system functioning at its best. For instance, to keep up with the energy requirements of a body affected by SARS-CoV-2, it is recommended to incorporate dextrose content and increase its intake progressively to satisfy energy demands.

According to the preceding discussion, regular monitoring of nutrition resistance is crucial in improving patients' treatment results. However, Reignier *et al.*³⁰ highlighted that regular monitoring and checks of gastric residual levels in patients, who are being provided enteral treatments, may sometimes not be effective. Intolerance to enteral nutrition is regularly observed and is expected to occur during the early and late periods of being affected by COVID-19. Therefore, regardless of the promise of nutritional therapies, they must be developed for each patient according to their specific needs and deficiencies.

CONCLUSION

Nutrition plays an undeniable role in maintaining a healthy immune system that, in turn, ensures protection against infectious viruses and diseases. A good diet prepares the body to react sufficiently to microorganisms. In the post-COVID-19 era, the general population ought to change their eating regimens to reduce their vulnerability to further such large-scale pathogenic attacks. Current research provides proof that early nutritional interventions may promote positive treatment outcomes. Therefore, people, who have already been affected by COVID-19 or any other such illnesses, must consider the guidance provided in this review paper to improve the results of the treatment provided to them.

SIGNIFICANCE STATEMENT

This study highlights the importance of the dependence of immune strength upon the quality of food intake, which is beneficial to understand that food high in nutritional content, such as fibrous supplements, particularly from plants, have many essential nutrients that are beneficial to the body due to their anti-inflammatory properties. Current study presents foundational information on the relationship of good nutritional intake with the immune system and provides recommendations that can help readers improve this relationship.

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