

REVIEW ARTICLE

COVID-19 and Impact of Nutrition

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ABSTRACT

Coronavirus disease (COVID-19) is an infectious disease that is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It has affected the entire world. The clinical course of infection varies from asymptomatic to mild symptoms to life threatening conditions in affected individuals. An unbalanced immune response is responsible for many complications and even death in severe cases. Poor nutritional status is a major risk factor for infection as it makes the patient immunocompromised. A good dietary pattern boost immune system in combating infections. In this review, the role of various dietary patterns, individual vitamins and trace elements will be considered. The link between diet and COVID-19 has yet to be established. However, findings from previous studies on respiratory tract infections have shown that diet plays an important role in the management and prevention of infections.

Key Words: COVID-19, Dietary Pattern, Nutrition, Vitamins.

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Introduction

Coronavirus disease (COVID-19) is a viral infection and caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Its outbreak began in the city of Wuhan, China, in December 2019, from where it has spread to the entire world.^{1,2,3} It has significant adverse effects on health and lives of people.^{4,5} SARS-CoV-2 is RNA virus and it mainly affects the respiratory tract. It spreads through human to human by droplets generated during sneezing and coughing of the affected person. Its clinical spectrum can range from asymptomatic infection to mild symptoms including cough, fever, shortness of breath and fatigue. Its severe symptoms include pneumonia, acute respiratory distress syndrome, sepsis, heart failure and multiple organ failure that leads to death.^{6,7} SARS-CoV-2 makes contact with the cell by binding of viral spikes proteins to angiotensin-converting enzyme 2 (ACE2) receptor. These receptors are particularly abundant on alveolar

epithelial cells.^{8,9} Virus binding and destruction of lung cells trigger immune responses in two stages. In most of the infected individuals, there are no or mild symptoms. It is hypothesized that disease progression is prevented in these individuals by an adaptive immune response by production of immunoglobulins against virus. In such cases, this immune process resolves infection. However in moderate to severe cases, an uncontrolled immune response leads to lung damage and functional impairment. Other features includes penetration of macrophages and monocytes into the lung, lymphocytes reduction in peripheral blood, extreme high level of proinflammatory cytokines that results in cytokine storm, lymph nodes and spleen atrophy and multiple organ dysfunction syndrome.^{10,11} In these cases, patients eventually die especially if there is damage to the renal, hepatic and cardiac systems.¹²

Dietary Pattern and COVID-19

Our diet is one the most important factor that directly influences our health. A good dietary pattern helps boost our immune system to fight against infections. Conversely, an unhealthy dietary pattern leads to oxidative stress and low-grade inflammation. The role of different dietary pattern and individual nutrients in relation to COVID-19 will be discussed in this section.

Western diet (WD) is consumed in developed

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countries. It contains high amounts of sugars, refined carbohydrates, saturated fat, and low amount of dietary fiber, antioxidants and unsaturated fats.¹³ The consumption of WD is linked with hyperglycemia, hyperlipidemia and promotes type 2 diabetes and obesity. These two conditions are risk factor for developing severe COVID-19 infection.^{14,15} WD cause chronic inflammation by activating the innate immune system and weakens the adaptive immune system. This chronic inflammation leads to impaired host defense against viruses.¹⁶

Another dietary pattern called Mediterranean diet is widespread in countries around the Mediterranean Sea. This dietary pattern is based on the use of fruits, vegetables, legumes, olive oil, whole grains, monounsaturated fats, fish, fermented dairy products and very low consumption of processed meat.¹⁷ Such a balance diet has anti-inflammatory and immunomodulatory properties. Many studies have shown beneficial effects of Mediterranean diet against diseases which are associated with chronic low-grade inflammation including obesity, cardiac problems and cancer.¹⁸ Mediterranean diet can be used in COVID-19 because it has a beneficial effect on immune health. Mediterranean diet contains large number of bioactive compounds along with vitamins and minerals.¹⁹ Clinical trials are required to assess the impact of the Mediterranean diet on the health of COVID-19 patients.

Ketogenic diet contains high amount of fat and low carbohydrates and moderated amount of proteins. It results in ketosis which is the production of ketone bodies like B-Hydroxybutyrate by burning of fats in the body for energy production. It was initially formulated for epilepsy patients to reduce seizures in 1923 by Dr. Russell Wilder. Later different variants of this diet were published to treat diseases that are due to metabolic dysregulation. Ketogenic diet performs anti-inflammatory and antioxidant activities.^{20,21} Currently, a trial is in progress (www.clinicaltrials.gov: NCT04358835) on COVID-19 patients with the aim of monitoring the effect of a ketogenic diet on the improvement of gas exchange, reduction of inflammation, and duration of mechanical ventilation.

Role of Individual Nutrients

Vitamin D

Vitamin D is formed in skin by sun exposure, also

known as the sunshine vitamin.²² Dietary sources of vitamin D include mushrooms and fish such as mackerel salmon, and herring. Vitamin D both from diet and skin is inert and it is activated in the body. In the liver, it is first changed to 25(OH)D and then in the kidney it is converted to 1,25(OH)2D.²³ This activated vitamin D enhances calcium and phosphorus absorption. Moreover, it also affects the immune system and interferes with T and B lymphocytes, neutrophils, dendritic cells and macrophages. It also reduces the production of proinflammatory cytokines and at the same time enhances the production of anti-inflammatory cytokines.²⁴ Furthermore, vitamin D induces the production of a peptide called cathelicidin that has antimicrobial activity against enveloped viruses such as coronaviruses, fungi and bacteria.²⁵ Studies have been conducted on vitamin D supplementation to see its effects on respiratory tract infection such as influenza. The results show that it helps in reducing infection. It is observed that the COVID -19 outbreak started in winter when the level of vitamin D is lowest. It has been observed that this deficiency contributes to acute respiratory distress syndrome and an increase rate of mortality. People at risk of infection should take vitamin D₃ about 10,000 IU/d to increase its level to 40-60 ng/ml. For COVID-19 infected people a high vitamin D₃ dose might be needed for treatment.²⁶ Clinical trials are needed to assess these recommendations.

Vitamin C

Vitamin C (ascorbic acid) is an essential, water soluble vitamin. Vitamin C is available in a variety of dietary sources such as berries, citrus fruits and many other vegetables and fruits. It is also available in the form of supplements.^{27,28} Vitamin C has both antioxidant and antiinflammatory properties which is important for a healthy immune system. Being immune modulator, it can perform a protective role in respiratory infections including COVID-19. During infection vitamin C level may reduce and patient might need vitamin C supplements.²⁹ Based on these evidences, a clinical trial (www.clinicaltrials.gov: NCT04264533) is currently in place in China. where 24g/day vitamin C infusion will be used to treat severe COVID-19 patients for seven days in the experimental group. While 50ml sterile water will be infused in the placebo group twice a day for seven

days. This study will be completed in September. It will help in providing important information about mitigating symptoms of COVID-19 by using vitamin C.³⁰

Vitamin E

Vitamin E is a fat soluble compound. Its dietary sources include vegetable oils, nut, green vegetables and cereals. Its antioxidant and Immunomodulatory properties have been evaluated in numerous animal and human studies. In cell membranes, it prevents oxidation of polyunsaturated fatty acids (PUFAs) and it also plays a significant role in signal transduction. Its deficiency damages both humoral and cell-mediated immune functions.³¹ So, it is important to explore beneficial effects of vitamin E against COVID-19.

Trace Elements

Zinc

Zinc is a vital trace element present in our diet that is important for maintaining the function of immune cells. Zinc deficiency can lead to defective immune function and increase susceptibility to viral infections. Studies revealed that zinc-deficient individuals are at increased risk of acquiring viral infection like HCV and HIV.^{32,33} It is suggested that an increase in zinc intake may be effective against COVID-19 infection because it has antiviral and immune modulatory properties.³⁴ However, observational studies and clinical trials are needed to establish a clear link.

Copper

Copper is also an essential trace element that is obtained from the diet. It has significant effects on the development of immune cells. Antiviral properties of copper have been established by *in-vitro* studies.³⁵ At present, there are no recommendations on dietary intake of copper against COVID-19.³⁶ Therefore, intensive research efforts are required to determine the effect of high intakes of dietary copper against viral infection.

Conclusion

Our diet has a significant effect on our health. A healthy dietary lifestyle can prevent and manage viral infections by boosting our immune system. However, it should be noted that there is no single dietary element that has been confirmed in treatment or prevention of COVID-19 infection. Ketogenic diet and dietary supplements are in

clinical trials and their results are awaiting.

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