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NUTRITION, IMMUNITY AND COVID-19

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Currently Covid-19 pandemic is a leading challenge across the globe. It is mandatory to attain and maintain good nutritional status to fight against virus. Nutritional status of individual is affected by several factors such as age, sex, health status, life style and medications. Nutritional status of individuals has been used as resilience towards destabilization during this COVID-19 pandemic. Optimal nutrition and dietary nutrient intake impact the immune system, therefore the only sustainable way to survive in current context is to strengthen the immune system. There is no evidence found that supplement can cure the immune system except Vit C, which is one of the best way to improve immune system. A proper diet can ensure that the body is in proper state to defeat the virus. However along with the dietary management guidelines the food safety management and good food practices is compulsory.

More than 2,500 years ago, Hippocrates said: **“Let food be thy medicine and medicine be thy food.”** Both nutrient intake and incidence of the disease usually influence the nutritional status particularly of developing nations, where everyone is striving for food. Inadequate diet and infectious diseases can lead to severe malnutrition. Currently, the COVID-19 pandemic is the leading challenge across the globe.

The immune system protects the host from pathogenic organisms (bacteria, viruses, fungi, parasites). To deal with this array of threats, the immune system has evolved to include a myriad of specialised cell types, communicating molecules and functional responses. The immune system is always active, carrying out surveillance, but its activity is enhanced if an individual becomes infected. This heightened activity is accompanied by an increased rate of metabolism, requiring energy sources, substrates for biosynthesis and regulatory molecules, which are all ultimately derived from the diet. A number of vitamins (A, B6 , B12, folate, C, D and E) and trace elements (zinc, copper, selenium, iron) have been demonstrated to have key roles in supporting the human immune system and reducing risk of infections. Other essential nutrients including other vitamins and trace elements, amino acids and fatty acids are also important.

It would seem prudent for individuals to consume sufficient amounts of essential nutrients to support their immune system to help them deal with pathogens should they become infected. The gut microbiota plays a role in educating and regulating the immune system. Gut dysbiosis is a feature of disease including many infectious diseases and has been described in COVID-19. Dietary approaches to achieve a healthy microbiota can also benefit the immune system. Severe infection of the respiratory epithelium can lead to acute respiratory distress syndrome (ARDS), characterised by excessive and damaging host inflammation and termed a cytokine storm. This is seen in cases of severe COVID-19. There is evidence from ARDS in other settings that the cytokine storm can be controlled by n-3 fatty acids, possibly through their metabolism to specialised pro-resolving mediators.

The immune system is functioning at all times, but cells become activated by the presence of pathogens. This activation results in a significant increase in the demand of the immune system for energy yielding substrates (glucose, amino acids and fatty acids). Various micronutrients (eg, iron, folate, zinc, magnesium) are also involved in nucleotide and nucleic acid synthesis. Some nutrients, such as vitamins A and D, and their metabolites are direct regulators of gene expression in immune cells and play a key role in the maturation, differentiation and responsiveness of immune cells. Creation of a pro-oxidant environment through generation of damaging reactive oxygen species is one element of innate immunity; the host needs protection against these through classic antioxidant vitamins (vitamins C and E) and the antioxidant enzymes (superoxide dismutase, catalase and glutathione peroxidase); the latter require manganese, copper, zinc, iron and selenium.

Thus, the roles for nutrients in supporting the function of the immune system are many and varied and it is easy to appreciate that an adequate and balanced supply of these is essential if an appropriate immune response is to be mounted. In essence, good nutrition creates an environment in which the immune system is able to respond appropriately to challenge, irrespective of the nature of the challenge. Conversely poor nutrition creates an environment in which the immune system cannot respond well.

There are a number of reviews of the role of vitamin A and its metabolites (eg, 9-cis-retinoic acid) in immunity and in host susceptibility to infection. Vitamin A also supports phagocytic activity and oxidative burst of macrophages, so promoting bacterial killing. Natural killer cell activity is diminished by vitamin A deficiency, which would impair antiviral defences.

Vitamin C is required for collagen biosynthesis and is vital for maintaining epithelial integrity. It also has roles in several aspects of immunity, including leucocyte migration to sites of infection, phagocytosis and bacterial killing, natural killer cell activity, T lymphocyte function (especially of CD8+ cytotoxic T lymphocytes) and antibody production. Vitamin C deficiency in animal models increases susceptibility to a variety of infections. People deficient in vitamin C are susceptible to severe respiratory infections such as pneumonia. A meta-analysis reported a significant reduction in the risk of pneumonia with vitamin C supplementation, particularly in individuals with low dietary intakes.

Vitamin D receptors have been identified in most immune cells and some cells of the immune system can synthesise the active form of vitamin D from its precursor, suggesting that vitamin D is likely to have important immunoregulatory properties. Vitamin D enhances epithelial integrity and induces antimicrobial peptide (eg, cathelicidin) synthesis in epithelial cells and macrophages.

Zinc deficiency has a marked impact on bone marrow, decreasing the number immune precursor cells, with reduced output of naive B lymphocytes and causes thymic atrophy, reducing output of naive T lymphocytes. Therefore, zinc is important in maintaining T and B lymphocyte numbers. Zinc deficiency impairs many aspects of innate immunity, including phagocytosis, respiratory burst and natural killer cell activity. Zinc also supports the release of neutrophil extracellular traps that capture microbes. There are also marked effects of zinc deficiency on acquired immunity. Circulating CD4+ T lymphocyte numbers and function (eg, IL-2 and IFN-γ production) are decreased and there is a disturbance in favour of T helper 2 cells. Likewise, B lymphocyte numbers and antibody production are decreased in zinc deficiency. Zinc supports proliferation of CD8+ cytotoxic T lymphocytes, key cells in antiviral defence. Many of the in vitro immune effects of zinc are prevented by zinc chelation.

Lower selenium concentrations in humans have been linked with diminished natural killer cell activity and increased mycobacterial disease. Selenium deficiency was shown to permit mutations of coxsackievirus, polio virus and murine influenza virus increasing virulence. These latter observations suggest that poor selenium status could result in the emergence of more pathogenic strains of virus, thereby increasing the risks and burdens associated with viral infection. Selenium supplementation (100 to 300µg/day depending on the study) has been shown to improve various aspects of immune function in humans.

Iron deficiency induces thymus atrophy, reducing output of naive T lymphocytes, and has multiple effects on immune function in humans. The effects are wide ranging and include impairment of respiratory burst and bacterial killing, natural killer cell activity, T lymphocyte proliferation and production of T helper 1 cytokines. T lymphocyte proliferation was lower by 50% to 60% in irondeficient than in iron-replete housebound older Canadian women. Evidence suggests that infections caused by organisms that spend part of their life-cycle intracellularly, such as plasmodia and mycobacteria, may actually be enhanced by iron. In the tropics, in children of all ages, iron at doses above a particular threshold has been associated with increased risk of malaria and other infections, including pneumonia.

The immune system protects the host from pathogenic organisms (bacteria, viruses, fungi, parasites). To deal with such an array of threats, the human immune system has evolved to include a myriad of specialised cell types, communicating molecules and functional responses. The immune system is always active, carrying out surveillance, but its activity is enhanced if an individual becomes infected. This heightened activity is accompanied by an increased rate of metabolism, requiring energy sources, substrates for biosynthesis and regulatory molecules, which are all ultimately derived from the diet. Through experimental research and studies of people with deficiencies, a number of vitamins (A, B6, B12, folate, C, D and E) and trace elements (zinc, copper, selenium, iron) have been demonstrated to have key roles in supporting the human immune system and reducing risk of infections. Other essential nutrients including other vitamins and trace elements, amino acids and fatty acids are also important in this regard. Many plant foods, fibre and fermented foods play a role in creating and maintaining a healthy gut microbiota and so will also help to support the immune system. Thus, specific nutrients and the foods that provide them can play a role in supporting the immune system in order that the host can better defend against bacteria and viruses if infected. Therefore, having a healthy diet could be an important factor, but one of many, in determining outcome in individuals should they become infected with coronavirus.

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