**Nutrition and Covid-19: A Systematic Review**

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**Abstract:** Nutrition plays a vital role in maintaining the health, helps to build stronger immune system and have a crucial role in combating Covid-19. A robust, balanced and diversified diet is essential for good health and boost immune system to fight against the virus. But, dietary requirements of individual are affected by number of factors such as age, health status and life style. This review summarizes the symptoms, transmission and nutritional status and its role in combating the disease.

**Keywords:** Nutrition, Covid-19, Immunity

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**Introduction**

Corona virus (CoV) has affected the life around the globe from past twenty years. In 2002, first epidemic due to corona virus originated in China, causing a severe acute respiratory syndrome (ARDS), called SARS-CoV (Da Costa et al., 2020). Subsequently, in 2012, a new viral outbreak with characteristics almost like SARS-CoV was observed within Middle East (Qatar, Jordan, Saudi Arabia, and the United Arab Emirates), in Europe (UK, France, and Italy), and in Africa, and was called as Middle East Respiratory Syndrome (MERS) (Calder et al., 2020). Later, in December 2019, a new type of corona virus (COVID-19) causing pneumonia and death was identified in Wuhan, China (Leung, 2020; Wu et al., 2020). This new corona virus is called SARS-CoV-2 because its genetic constitution is very much similar to SARS-CoV. It causes the severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) which raised the public concern (James et al., 2021). SARS-CoV-2 is the seventh known human corona virus (Chen et al., 2020). It was declared as the outbreak of a global pandemic in March 2020 by World Health Organization (WHO, 2020).

Almost within two weeks the virus’s gene sequence was identified and a testing method was developed (Zhu et al. 2020), so as to develop a protective vaccine (Yan et al., 2020). Earlier, other testing methods were also developed which involves the measurement of infection (using RT-PCR) and antibodies formed after being infected (using immunoassays) (Elfaitouri et al., 2005; Souf, 2016, Morawska and Cao, 2020). However,
attempt are still going on to explore the most effective preventative and curative methods against Covid-19 (Bousquet et al., 2020; Gralinski and Menachery, 2020; Park et al., 2020; Zhou et al., 2020). As the pandemic unfolds, it exacerbates the risk factors for malnutrition in all its forms (Headey et al., 2020; Akseer et al., 2020). Disruption to agricultural production, market linkages, and seasonal labor movements contribute to food price increases (Torero, 2020; Philip et al., 2021), making nutritious food even more expensive for those most at risk of micronutrient deficiencies and under nutrition. Due to delay and cancellation in micronutrient distributions, school meal programs, nutrition counseling programmes and vaccine rounds have accentuated the vulnerability (Perez-Escamilla et al., 2020; Dunn et al., 2020). There was also increase in physical and psychological barriers to healthy eating and exercising due to lockdown creating an obesogenic environment for many (Di Renzo et al., 2020; Muscogiuri et al., 2020; James et al., 2021).

This review involves the collection of research papers and review articles from different sites/forums available on Google search up to 30.07.21. The important points of various studies are summarized in this review.

Corona viruses and Symptoms:

Corona viruses are a large group of single-stranded RNA viruses that are common among mammals and birds. They cause respiratory and, less frequently, gastrointestinal diseases (Weiss and Leibowitz, 2011; Su et al., 2016). Common symptoms of the disease include fever, sore throat, cough, loss of taste or smell, difficulty in breathing, muscle aches and tiredness. Severe cases might experience shortness of breath (low oxygen level), high grade fever, pneumonia, acidosis, blood clots, heart problems, lung damage (acute respiratory distress syndrome), kidney damage, multiple organ failure and death. But, the severity of disease varies from one person to another. Some are completely asymptomatic, some might experience only mild symptoms, while some people have severe symptoms that can lead to hospitalization, and in severe cases death takes place (Fernandez-Quintela et al., 2020). The most serious clinical conditions are characterized by acute respiratory distress syndrome (ARDS), cardiac insufficiency, and septic shock (Zhou et al., 2020; Pomara et al., 2020; Salerno et al., 2020), causing tissue damage at the alveolar level, resulting into pathological tissue alterations, hyperplasia and infiltration. In addition, the existence of different comorbidities in patients infected with SARS-CoV-2 may elevate the response of the immune system, aggravate the risk of adverse effects and mortality (D’Errico et al., 2020; Cipolloni et al., 2020; Sessa et al., 2020). In patients suffering from non-communicable diseases (such as diabetes and arterial hypertension), systemic inflammation is strictly related to severe symptoms after the SARS-CoV-2 infection (Cavaliere et al., 2019; Gupta et al., 2020; Moscatelli et al., 2021).

The risk of disease is proportional with age i.e. older people are more prone to corona virus. However, people with existing medical conditions also have a higher susceptibility of catching infection resulting into serious illness.

Transmission/Infection:

Covid-19 virus is communicable and easily spreads from one person to another. The virus is present in respiratory droplets and can be transmitted through breath, cough and sneeze and even talking with affected person if there is close contact. The virus can also be transmitted when the contaminated surfaces or objects are touched by uninfected people. The virus can enter through mouth, nose or eyes of a person. According to UKRI (2020) SARS-CoV-2 can survive in air droplets for maximum three hours and for up to three days on hard surfaces. Therefore, WHO (2020a) recommended frequent hand-washing and maintaining a distance of at least one meter as main safety precautions against the COVID-19.
Besides this, the COVID-19 virus can also spread through droplets or aerosols (i.e. airborne transmission) that remain present in the air for several minutes or hours. There is not much evidence to air borne transmission but, several studies explained the route of transmission (Olsen et al. 2003; Li et al., 2005; Yu et al., 2005; Booth et al. 2005; Xiao et al., 2017). Therefore, it is highly likely that airborne transmission causes the spread of virus in the indoor cases studied. WHO (2009) in a review of the evidence stated that aerosols (e.g. airborne infections) are responsible for the transmission of viral infections across distances in the indoor environments resulting into large clusters of infection in a short period of time. As there are the many similarities between the two SARS viruses and the evidence on route of virus transmission, it is concluded that the SARS-CoV-2 virus also spreads through air (Fineberg, 2020; Morawska and Cao, 2020).

Nutrition and its role in Covid-19:

Proper diet is essential to maintain good health and sustainable way to strengthen the immune system to defeat the virus. Strong Immune system of human being depends upon optimal nutrition and dietary nutrient intake, which affects through gene expression, cell activation, and signaling molecules modification. Nutrients like zinc, iron, and vitamins A, B_{12}, B_{6}, C, D and E are essential for supporting, strengthening and maintenance of immune function (Aman and Masood, 2020). The healthy maintenance of the immune system strictly depends upon vitamins such as D, C, A (including β-carotene), and those of group B (particularly B6, B12 as well as folate) as listed by The European Food Safety Authority (EFSA) scientific panel. Zinc, copper, iron and selenium also have similar roles (Mentella et al., 2021). Similarly, Carder (2020) enlisted that a number of vitamins (A, B_{6}, B_{12}, folate, C, D and E) and trace elements (zinc, copper, selenium, iron) have important roles in the maintenance of human immune system and thereby reducing risk of viral infections. Apart from these, essential nutrients such as other vitamins, amino acids, fatty acids and trace elements are also included.

Galmes et al. (2020) have published an updated report on the relevance of optimum nutrition as an important factor to enhance an immune system. Results from their review emphasize the importance of preserving a well-balanced level of these ten nutrients, especially the key role played by vitamin D and iron in the current pandemic. Inadequate intake of iron and vitamins B_{12}, C and D and other relevant micronutrients have shown inverse correlation with higher disease incidence and fatality rate, especially in populations showing genetic predisposition to poorer micronutrient status. Further, Calder et al. (2020) reported that an adequate nutrition regimen is essential in the defense against viral threats. They reported that vitamin C is pivotal in supporting and boosting the immune system. It is one of the major constituents of water soluble vitamins which tend to make a strong immune system. The daily recommended dietary requirement for vitamin C is 90 mg/d for men and 75 mg/d for women. Therefore, balanced nutrition is essential in maintaining regulated immune homeostasis.

On the other hand, global COVID-19 outcomes are affected by the wide prevalence of malnutrition and trace element deficiency (Fedele et al., 2021, Mentella et al., 2021). Recent studies have reported how malnutrition is one of the crucial elements that may be predictive of slower recovery or no recovery at all, for the affected subjects (Bold et al., 2020). Malnutrition refers to the incorrect intake of energy rich foods as well as foods that are deficient in macronutrients (carbohydrates, proteins, fats), and micronutrients (minerals and vitamins). Moreover, deficient energy rich food includes those foods that fails to meet the individual’s body energy requirement, whereas lack of vitamins and minerals which are needed, in small amounts, for healthy growth and development is referred as micronutrient deficiency. Although it might seem contradictory,
individuals might be overfed in terms of energy but be deficient in one or more micronutrients in their routine diet. Inadequate intake of these nutrients lowers the resistance to infections and, consequently increases the seriousness of the disease (Calder et al., 2020). Recently, two studies were conducted and compared the effect of malnutrition in elderly patients and COVID-19. Firstly, Li et al. (2020) conducted a study on 182 elderly hospitalized COVID-19 patients (≥65 y in 1 center) in Wuhan, China. They found that 53% patients were classified as malnourished and 28% were at risk of malnutrition. The second study analyzed nutritional status among 141 COVID-19 elderly patients (>65 y) in 1 hospital in China. They found severity of disease in patients that had comparatively longer hospital stay, poor appetite and greater weight loss as compared to patients not at nutritional risk (Liu et al., 2020).

Therefore, in the current situation, it is utmost important to include the specific types of food that can boost our immune system (Anton and Miller, 2005; Haug et al., 2007). Here are some professional and authentic dietary guidelines which should be included in the diet (Khayyatzadeh, 2020; Aman and Masood, 2020) to withstand COVID-19:

- **Daily 2 cups (4 servings) fruits-** (e.g. seasonal fruits such as, guava, apple, banana, strawberry, grapefruit, pineapple, papaya, orange etc.).
- **Daily 2.5 cups of vegetables (5 servings)-** Seasonal fresh vegetables (e.g. bell peppers, garlic, ginger, lime, coriander, broccoli etc.), legumes (beans and lentils).
- **Avoid junk food and irregular snacking,** replace it with fresh fruits and raw vegetables. Foods that are high in sugar, salt or fat should be avoided.
- **Unprocessed grains,** e.g. maize, oats, wheat, millet, brown rice or roots such as yam, potato, taro or cassava (180 g).
- **Nuts like almonds, raisins coconut, and pistachio** must be included in the diet.
- **Optimal diet should have food from animal sources** (e.g. fish, eggs, and milk) and Red meat (once or twice per week) and poultry (2–3 times per week).
- **Vegetables should not be overcooked as important nutrients such as vitamins and minerals will be lost.**
- **In case of dried or canned fruits and vegetables, without added sugar or salt should be preferred.**
- **Food should be prepared and served at optimum and acceptable temperatures i.e. ≥72 C for 2 min.**
- **Maximum 5 g of salt per day.**
- **Use unsaturated fats** (present in avocado, fish, nuts, soy, olive oil, canola, corn oil, and sunflower) instead of saturated fats (present in butter, fatty meat, coconut and palm oils, cheese, ghee, and cream).
- **Water helps in the transport of nutrients in the blood, eliminates waste, and also regulates the body temperature.** Hence, drink 8–10 glasses of water per day.
- **Avoid drinks that contain sugar i.e. fizzy, carbonated and concentrated juices etc.**
- **Exercise, meditation, and regular sleep** in order to maintain a healthy lifestyle which will help to build immune system stronger.
- **Avoid eating outside as it will reduce the chance of being exposed to COVID-19.**

Butler and Barrientos (2020) reported that the diseases such as obesity and type 2 diabetes due to unhealthy life style and consumption of food stuffs rich in saturated fats, sugars, and refined carbohydrates, could increase the risk for severe COVID-19 pathology and mortality. Unhealthy diet has adverse consequences in case of peripheral inflammation caused by COVID-19 that may have long-term consequences in those that recover, likely through neuroinflammatory mechanisms, resulting into chronic medical conditions such as dementia and neurodegenerative disease. Moreover, some studies also suggest that diseases due to unhealthy life style have adverse effects on
acquired immunity as well. In case of SARS-CoV-2 there was no underlying existing natural immunity against it, as it is new to the human immune system. The disease (diabetes, non-alcoholic fatty liver disease), neurodegeneration and in some cancers can cause an excessive inflammatory response when infected with coronavirus. Although inflammation is part of the innate immune response and innate, but an excessive inflammatory response can lead to impairments in acquired immunity. Further, unhealthy life style can lead to obesity, resulting in more severe COVID-19. Further, according to a French report 85.7% of SARS-CoV-2 infected obese individuals required mechanical ventilation as compared to 47.1% of infected healthy weight individuals (Simonnet et al., 2020; Calder, 2020).

Conclusion

The review concludes the importance of balanced and proper diet for maintaining health, building immune system to protect and fight against the coronavirus and recovery time will be faster.

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