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Nutrition and Infection with COVID-19

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Coronavirus disease 2019 (COVID-19) is an acute respiratory disease caused by a newly identified β-coronavirus. It started from Wuhan city of Hubei province of China in December 2019 and spread rapidly throughout the world. This global pandemic has caused dramatic impacts on nations' healthcare systems and socio-economic stability. It transformed into a worldwide public health emergency in a short time. No approved treatment exists for COVID-19 currently, so that the prevention principles are used as the best approach to control this infection. Along with considering environmental, public hygiene, and supportive pharmacological management, it would be crucial to provide adequate hydration and a healthy diet for all individuals. Little data are available on the effect of nutrition on this infection. The common clinical features of COVID-19, include cough, fever (not in all), sore throat, headache, fatigue, headache, lethargy, myalgia, and breathlessness (Guan *et al.*, 2020). It also has some similar features as other viral diseases, such as seasonal influenza. General nutritional recommendations may be advised for the prevention and management of this new viral disease. Special attention should be paid to promote immune function to enhance the people viral resistance. Specific nutritional deficiencies may result in immune dysfunction leading to increased susceptibility to infectious diseases. Dietary insufficiency of protein, vitamin C, vitamin E, vitamin A, zinc, selenium, and omega-3 fatty acids may also increase its susceptibility, which should be assessed in high-risk groups (Field *et al.*, 2002).

Protein-energy malnutrition (PEM) is a condition that causes immunodeficiency and predisposes infection. Furthermore, infection causes a metabolic disturbance enhancing catabolism. This malnutrition–infection cycle is related to significant morbidity and mortality worldwide, particularly in vulnerable populations (Woodward, 1998). To control PEM, energy and protein requirements should be calculated appropriately and food sources containing high protein and energy are recommended for individuals with a high risk of infection.

The importance of vitamin A in immune function and protection against infections is well established, so that its deficiency is a major public health

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problem in many developing countries. Vitamin A is involved in maintaining immunity and its deficiency was associated with some viral diseases such as measles and viral diarrhea (Kańtoch *et al.*, 2002). Jee et al. stated that vitamin A supplementation improved disease prognosis and reduced morbidity and mortality in individuals with malaria, lung diseases, and human immunodeficiency virus (HIV) (Jee *et al.*, 2013). Vitamin A deficiency often co-exists with protein-energy malnutrition and its deficiency can be corrected by initial treatment of the PEM (World Health Organization, 2009). Animal sources of protein usually provide good amounts of vitamin A; therefore, high protein diet including fish, meat, poultry, egg, and dairy products should be recommended in the daily meal plan (Gwin *et al.*, 2019).

Vitamin C, present in leukocytes, is rapidly used up during infection. This water-soluble vitamin, as an anti-oxidant increases the immune function strongly and reduces the duration and severity of common cold (Hemilä and Douglas, 1999). Placebo-controlled trials indicated that vitamin C supplementation reduced the incidence of pneumonia and viral respiratory infections (Atherton *et al.*, 1978). In addition, vitamin C has a weak antihistamine effect, which may improve flu-like symptoms such as sneezing, running or stuffy nose, and swollen sinuses (Field *et al.*, 2002). Considering the presence of lower respiratory tract infection in COVID-19, higher dietary intake of vitamin C sources such as citrus fruits and green-leafy vegetables or supplements are recommended (Chambial *et al.*, 2013).

Zinc, a dietary trace element with immunomodulating functions, is vital in generating both acquired and innate antiviral responses (Read *et al.*, 2019). Zinc deficiency is relevant to cell-mediated immunity and H1N1 influenza (Castaño *et al.*, 2006). Administration of zinc was significantly effective in reducing the severity and duration of cold symptoms (Prasad *et al.*, 2000). Zinc supplementation caused beneficial and therapeutic effects for cell-mediated immunity and infection reduction in patients with viral diseases. Based on the previous randomized- clinical trials, co-administration of zinc and antiviral therapy may contribute to improved clinical outcomes in patients with AIDS (Asdamongkol *et al.*, 2013, Baum *et al.*, 2010). Along with intake of zinc supplementation, vulnerable groups were also recommended to consume adequate amounts of rich common dietary sources of zinc such as red meat, poultry, or seafood (Solomons, 2001).

Dietary long-chain poly unsaturated fatty acid (PUFA) derived from fish oil was observed to improve chronic inflammatory and autoimmune disorders (Calder, 1998). However, supplementation with long-chain n-3 PUFA resulted in favorable effects on the immune system and reduced disease severity in animal models. In this regard, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were most beneficial. Controversial effects of consuming fish oil administration on the immune system were reported in humans (Clark and Parbtani, 1994, Das, 1994). In an experimental study, fish oil consumption was associated with increased severity of an influenza virus infection (Schwerbrock *et al.*, 2009). Therefore, n-3 PUFA supplementation may not be safe and advantageous for all people and caution should be taken in n-3 PUFA supplementation in humans. However, dietary intake of n-3 PUFA such as salmon, sardine, canola, walnut, and soy is advisable.

Vitamin E, a lipid soluble antioxidant and selenium, is an essential trace element and the main component of antioxidant defenses. Epidemiological studies demonstrated that deficiencies in either vitamin E or selenium increased viral pathogenicity and altered immune responses (Arthur *et al.*, 2003, Beck, 2007). Vitamin E or selenium supplementation may result in immune benefits, decreased inflammation, and viral load in animal trials (Supúlveda *et al.*, 2002, Tantcheva *et al.*, 2003). Given the limited data over vitamin E or selenium supplementation in human, all individuals should be encouraged to consume adequate dietary intakes of these antioxidants.

In conclusion, no information is available on the association between diet and COVID-19. In addition, investigations of the nutrients'

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supplementation have been limited to animal studies and human data are scarce. We recommend all people to consume varied and healthy foods rich in immunomodulating nutrients. In the case that PEM is manifested in individuals, it should be corrected rapidly. Furthermore, some nutrient supplementations such as vitamin C, vitamin E, selenium, and zinc may have beneficial effects on patients with COVID-19.

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