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The role of nutrition in strengthening immune system against newly emerging viral diseases: case of SARS-CoV-2

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ABSTRACT

The immune system is involved in the protection of host against environmental agents such as pathogenic micro-organisms (bacteria, fungi, and viruses) and chemicals, thereby preserving the integrity of the body. To preserve organism defense mechanisms, adequate nutritional status should be maintained with appropriate intakes of calories, vitamins, minerals and water that should be continuously provided by a healthy diet. The emergence of new infectious diseases with new pathogenic properties constitutes a serious health issue worldwide. Severe acute respiratory syndrome (SARS) represents one of the most recent emerging infectious diseases, caused by a novel coronavirus member called (SARS-CoV-2), identified in Wuhan, Hubei, China in December 2019, and recognized as pandemic by the World Health Organization (WHO). The nutritional status of each COVID-19-infected patient should be assessed prior undertaking treatments. Nutritional support should be the basis of management of any infected individual. However, prevention measures remain the first priority and strategy to develop throughout proper hygiene, healthy diet and staying home.

Keywords: Nutrition, Immune system, Viral diseases, SARS-CoV-2

1. INTRODUCTION

It is well established that diet constitutes a critical determinant of immune status, and malnutrition is the most common cause of immunodeficiency worldwide (Figure 1) [1]. Cell-mediated immunity impairment, phagocyte function, complement system, cytokine production, and immunoglobulin A antibody secretion, are overall associated with protein-energy malnutrition. Deficiency of single nutrients could result in altered immune responses such as zinc, selenium, iron, copper, magnesium, manganese, vitamins A, C, E, and B-6; and folic acid influencing immune responses [2,3].

2. ROLE OF MACRO- AND MICRONUTRIENTS

Historically speaking, the immune and the digestive systems have been, for a long, time considered as separate

entities, while, both systems are sharing important functions in terms of nutrients acquisition and host defense as our gut microbiota. The role of specific macro- and micronutrients in immune function has been extensively discussed in the literature. Immune cells may be particularly sensitive compared to other types of cells to the status of certain nutrients and food components.

Nutritional status, as a modifiable factor, is a key element in the functioning and maintaining of our immune system integrity and remains closely associated with immunity and host resistance against any infectious agent. To function correctly, the immune system is depending on adequate amounts of nutrients (carbohydrates fats and proteins, as well as water and micronutrients such as vitamins and minerals).

It is well stated that deficiency or insufficiency in nutrients, caused by inadequate intake, reduced absorption or bio-availability require corrections to properly maintain the immune system function. Concerning certain nutrients, increased intake above nutritional recommendation can optimize immune defense mechanisms [4].

2.1. ROLE OF MACRONUTRIENTS IN IMMUNE FUNCTION (Carbohydrates, Fats and Proteins)

Carbohydrates are primarily considered as the main source of calories that should consistently be covered. Immunomodulatory properties have been attributed to protein intake and particularly to some amino acids such as arginine, glutamine, taurine and sulfur-containing amino acids [5].



Figure 1: Worldwide burden of malnutrition (World Health Organization, WHO) [1]



Figure 2: Novel Coronavirus (COVID-19) Situation in the World (World Health Organization, Esri | WHO) [1]

Declines in both specific and non-specific immunity have been reported in association with under-nutrition and protein deficiency. Furthermore, some polyunsaturated fatty acids (PUFA), as well as their metabolic derivatives, contribute to regulating cell functions, especially omega-3 fatty acids (EPA and DHA) that influence immune cell functions [3].

2.2 ROLE OF MICRONUTRIENTS (Vitamins and minerals)

Deficiencies of trace elements such as iron, selenium, copper, and zinc, and vitamins A, B6, B12, folic acid, C, D and E are associated with immune dysfunction. A healthy balanced diet has the opportunity to furnish most of the essential micronutrients to exert modulatory effects on immune function, including zinc, iron, magnesium, manganese, selenium and copper that contribute to immune cells and functions sustainment and modulation [3,6]. Several epidemiologic and clinical studies suggest that the risk of infection is favored by nutritional deficiencies besides poor personal hygiene, sanitation, or contaminated food and water [7]. To date, food safety authorities worldwide have not authorized any privilege for any food or any nutrient to be labelled as protecting against infection.

During the last few months, a novel coronavirus has emerged from the Chinese city of Wuhan and spread around the world.

3. NUTRITION AND NEW EMERGED VIRAL DISEASE

What is a novel coronavirus?

The WHO defines coronaviruses as a large family of viruses that may cause illness in animals or humans. In humans, several coronaviruses are recognized to induce respiratory infections ranging from the common cold to more severe diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). The most recently discovered coronavirus causes coronavirus disease COVID-19 (Figure 2). This new virus and disease were unknown before the outbreak began in Wuhan, China, in December 2019 [1]. According to the Centers for Disease Control and Prevention (CDC), "A novel coronavirus is a new coronavirus that has not been previously identified. The virus causing coronavirus disease 2019 called COVID-19, is not the same as the coronaviruses that commonly circulate among humans and cause mild illness, like the common cold." A diagnosis with coronavirus 229E, NL63, OC43, or HKU1 is not the same as a COVID-19 diagnosis. Patients with COVID-19 will be evaluated and cared for differently than patients with common coronavirus diagnosis [8,9].

3.1. NUTRITIONAL INTERVENTION AND SUPPORT FOR CRITICALLY AFFECTED COVID-19 PATIENTS

Further to clinical management, nutritional support is the basis of treatment. It's important to establish individual therapy regimens and to assess, monitor and adjust dynamically. At the first stage, the nutritional risk assessment tools can include nutritional risk screening (NRS 2002), nutritional risk score for critically ill patients (NUTRIC score), or further tools for patients affected with COVID-19. Patients staying in the intensive care units (ICU) should be early assessed for nutritional risk. Therefore, an early enteral nutritional support should commence within 24 to 48 hours. Post-pyloric feeding will be favored when aspiration risk is high, age > 70 years, consciousness level affected, prone position, gastroesophageal reflux and a single load of enteral nutrition [10].

A. Energy and protein supply.

It is recommended to supply 20 ~ 30 kcal.kg⁻¹.d⁻¹ depending to the severity of the disease. Most guidelines consider that the protein requirement is suitable in the range of 1.2 to 2.0 g.kg⁻¹. Muscle atrophy could occur in severe patients due to increased protein catabolism and supplementing protein intake can reduce mortality [11-13].

Omega-3 polyunsaturated fatty acids (PUFA)

Omega-3 and omega-6 PUFAs predominantly promote anti-inflammatory and pro-inflammatory effects. Being precursors of resolvins /protectins and prostaglandins/leukotrienes, respectively, omega-3 including protectin D1, serving as a novel antiviral drug, could be considered for one of the potential interventions of the novel virus COVID-19 [4].

B. Micronutrients (Vitamins and minerals)

→ Vitamin A

It is well documented that an impaired immune response is due to deficiency of a particular nutritional element. It was reported that low vitamin A diets might compromise the effectiveness of inactivated bovine coronavirus vaccines and render calves more susceptible to infectious disease. Therefore, vitamin A could be a promising option for the treatment of this novel coronavirus and the prevention of lung infection [14].

→ B Vitamins

COVID-19 patients should be supplemented to enhance their immune system. Therefore, B vitamins could be chosen as a basic option for the treatment of COVID-19 [14].

→ Vitamin C

It is well known that vitamin C supports immune functions and protects against infection caused by coronavirus. The COVID-19 had been reported to infect the lower respiratory tract, and vitamin C could be one of the effective alternatives to treat COVID-19. It was reported throughout some controlled trials that vitamin C-supplemented patients presented, under certain conditions, lower incidence of pneumonia. However, supplying patients with high-dose vitamin C has not been received any evidence-based approval [14,15].

→ Vitamin D

Vitamin D is known to play a role by stimulating maturation of several cells including immune ones. A significant number of healthy individuals have been found to be with decreased levels of vitamin D, particularly at the end of Winter season that coincides with COVID-19 discovery in Winter of 2019 [4,16].

→ Selenium, Zink and Iron

Supplementing COVID-19 affected patients with selenium could be an effective intervention for the treatment of this novel virus. COVID-19 related symptoms such as diarrhea and lower respiratory tract infection could be improved by Zinc supplementation. It has been shown that Iron deficiency constitutes a risk factor for the development of recurrent acute respiratory tract infections [4,17,18].

4. COVID-19 AND PHYSICAL ACTIVITY

With the rapid coronavirus spread, the general population has been highly advised, for safety and prevention, to reduce moving and traveling and stay at home aiming to limit the COVID-19 transmission [1]. Unfortunately, such restrictions against regular physical activities will unavoidably affect individuals' routine daily activities, psychosocial status and well-being and may increase sedentary behavior with lowering energy expenditure, favoring screening activities such as watching television, using mobile devices and playing games. Therefore, physical activity should be maintained even at home using home exercises, as walking, push-up, etc. at least 30 min of moderate physical activity every day and/or at least 20 min of vigorous physical activity every other day. If available, some home exercises require equipment, little space, and can be practiced at any time that will help to reduce considerably stress, anxiety and depression, particularly during the current circumstances [19].

5. CONCLUSION

Nutrition constitutes a fundamental element in the development and the decline of immune status by maintaining immune homeostasis throughout life and reinforce immunity mechanisms especially among vulnerable individuals (elderly, pregnant, and infant groups). Nutritional support remains the basis of the treatment and no specific food or supplement will prevent COVID-19/Coronavirus affection. Therefore, we suggest to assess the nutritional status of COVID-19 infected patients prior undertaking general treatments.

Due to the increasing propagation of COVID-19, it is vital that infection control and safety precautions must be strictly adhered to minimize contamination. Home stay is a fundamental safety step that can limit infections from spreading widely. Regular physical activity and routinely exercising in a safe home environment should be maintained to avoid anxiety and depression and that constitutes a strategy for healthy living during the coronavirus crisis. However, appropriate and continuous hygiene practice and limit contact with people remains the best means of avoiding infection.

Frequently Asked Questions (FAQs) From USDA and CDC official websites.

Q: Can I become sick with coronavirus (COVID-19) from food?

A: We are not aware of any reports at this time of human illnesses that suggest COVID-19 can be transmitted by food or food packaging. However, it is always important to follow [good hygiene practices](#) (i.e., wash hands and surfaces often, separate raw meat from other foods, cook to the right temperature, and refrigerate foods promptly) when handling or preparing foods.

Q: Are meat products compromised by the Coronavirus?

A: We are not aware of any reports at this time of human illnesses that suggest COVID-19 can be transmitted by food or food packaging. However, it is always important to follow [good hygiene practices](#) (i.e., wash hands and surfaces often, separate raw meat from other foods, cook to the right temperature, and refrigerate foods promptly) when handling or preparing foods.

Currently, there is no evidence to support transmission of COVID-19 associated with imported goods and there are no reported cases of COVID-19 in the United States associated with imported goods.

Q: Can the coronavirus be spread through food, including refrigerated or frozen food?

A: According to the [CDC](#), "Coronaviruses are generally thought to be spread from person-to-person through respiratory droplets. Currently there is no evidence to support transmission of COVID-19 associated with food."

The following updatable resources can be consulted for accurate and up-to-date information about the COVID-19 development and management:

- [World Health Organization](#)

- [Centers for Disease Control and Prevention](#)
- [National Institutes of Health](#)
- [U.S. Department of Agriculture](#)
- [U.S. Food and Drug Administration](#)
- <https://www.unicef.org/stories/novel-coronavirus-outbreak-what-parents-should-know>
- <https://www.fda.gov/food/food-safety-during-emergencies/food-safety-and-coronavirus-disease-2019-covid-19>

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