

Dietary management to build adaptive immunity against COVID-19

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Abstract: Today's technology laced world progression has given a setback to human health. The world has faced the adversity of many new borne deadly pathogens such as Ebola, SARS, MERS and COVID-19. The human body has inherent and adaptive immunity which fights back with pathogens. Mostly the adaptive immunity is built by vaccinations or certain medications. But many research outcomes have shown that a diet filled with nutrients and right choices of food can help to build adaptive immunity. Micronutrients such as vitamins A, C, D, E, B2, B6, and B12, folic acid, iron, selenium, and zinc are important for avoiding pathogens attacks on human body. The deficiencies prevailing in body could be improved by supplementation of nutrients in accordance to recommended dietary allowances will help strengthen the immune system in return. We presently know only diet is not sufficient in fighting against pathogen attacks but the role of diet cannot be ignored in controlling infections. In this scenario, this review aims at summarizing those studies which demonstrated that supplementation of above micronutrients can help fight COVID-19 in specific.

Keywords: COVID 19, Adaptive Immunity, Nutrition, Vitamins, Minerals.

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I. INTRODUCTION

Coronavirus disease (COVID-19) is an infectious disease caused by a novel corona virus called SARS-CoV-2 [1]. The disease causes respiratory illness (like the flu) with symptoms such as a cough, fever, and in more severe cases, difficulty breathing [2]. One can protect self by washing hands frequently, avoiding touching face, and avoiding close contact (maintaining 1 meter or 3 feet) with people who are infected [3]. Adaptive Immunity is the system that our body developed to fight any bacteria, viruses or substances which are previously unknown to it. The whole immune system needs to be strong enough in order to fight with any diseases caused by these foreign substances. So this theory itself explains the people recovering from corona virus attack are with strong immunity, most probably the young age. On the other hand, old age people and children have weak immunity comparatively and thus more prone to get infected severely with these infections. According to World Health Organization (WHO) 55 years is the beginning of old age at which one start losing active life. The ageing results from the destruction of cells at molecular levels leading to gradual reduction in

physical and mental capabilities, which makes them more prone to diseases and untimely death [4].

The term "immunity" was first medically used by a Dutch physician, Van Sweiten in 1775. He used the term "Immunitas" to refer effects seen by early attempts at variolisation [5]. The Merriam-Webster dictionary, states the definition of immunity as: "the quality or state of being immune, especially: a condition of being able to resist a particular disease especially through preventing development of a pathogenic microorganism or by counteracting the effects of its products". In biological terminology, immunity is the capability of the body to fight against infections, diseases and other foreign invasions with proper tolerance to allergies and autoimmune diseases. Immunity responds in a co-ordinated fashion to the environment of numerous threats. It is necessity for the maintenance of good health, from the time the mother's immune system protects the growing baby, till old age. Immunity is basically acquired by the body in two ways; one is the innate immunity while the other one is adaptive immunity. Innate immunity or the native immunity has its existence from

the genes and is not induced artificially through drugs or other external stimulation or history of infection, but is the first response to the foreign invasion in the body. It is of two types as : (a) Non-Specific innate immunity, which provides resistance to all general infections. (b) Specific innate immunity is the inborn resistance to a particular kind of microorganism. Adaptive immunity is what is acquired through time and contact with a disease-causing agent, by introduction to deliberate actions such as vaccination. Unhealthy foods are those which are processed or refined. Like diets rich in refined sugars or trans-fats are harmful for the body as well as brain health. More of refined sugar impairs the insulin mechanism and increases the inflammation in the body thus leading to oxidative stress. From many studies it has been found that there is a direct relation between a diet rich in refined sugars and impaired immune functions. More of refined sugars can even cause mood swings and severe conditions like depression and weakened immune system [6].

One of the most important factors adding up to the competency of the immune system is the nutritional status. If a person is under nourished, he/she is more susceptible to infections and diseases; since the activities of the immune system get suppressed due to lack of energy and important nutrients intake. The other reason can be specific nutrient or of more than one nutrient deficiency. Essential nutrients needed for efficient functioning of the immune system includes Vitamin A, Vitamin C, Vitamin E, Essential amino acids, Essential fatty acid, Linoleic acid, Folic acid, Zinc, Copper, Iron and Selenium [7].

“A vitamin is a substance that makes you ill if you don’t eat it.” (Albert Szent-Gyorgyi, Nobel Prize in Physiology or Medicine, 1937).

Activation of Immune System

The foreign organisms are not recognized by the body and these are called antigens. These antigens are proteins present on the surface of Bacteria, Viruses and Fungi. When these antigens try to attach themselves to the immune cells and once they are successful then a series of reactions occur in the body. Now body starts recognizing the foreign invasion and fights back. The body stores this incident like a data regarding the attack and the procedure to fight it for future if it happens again. Sometimes though rarely human body recognizes its own antigens as foreign material and its immune system starts attacks its own cells which are harmless. This is called as an autoimmune response.

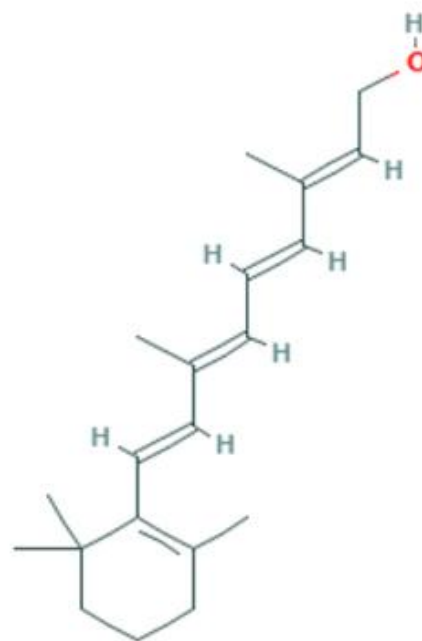
Nutritional recommendations to boost Immunity

Nutrition acts as a modifiable factor in impacting immune system function and researches in this field are called as

Nutritional Immunology. Below are some of major nutrients which qualify to maintain our Adaptive immunity.

Vitamin A

The category of Vitamin A (figure 1) comes under the type of fat soluble vitamin. It is a group of unsaturated monohydric alcohols containing an alicyclic ring [8]. One of a major nutrient helpful in building immunity is Vitamin A. An observation was made that there is a strong link between vitamin A and immunity, even before the structure of vitamin A was deduced [9]. Vitamin A is called as the “anti-inflammation vitamin”. Both the innate and adaptive immunity system is affected by the role of vitamin A as it promotes and regulates immune system; thus enhancing the functions of the immune system and increases the capability of the body to fight against a number of infectious diseases [10]. Vitamin A is present in the forms such as *all-trans*-retinol, retinyl esters or β -carotene [11]. The food products rich in Vitamin A are Pumpkin, Carrots, Broccoli, Spinach, Squash, Sweet potato, Mangoes, Papaya, Cantaloupes, Apricots and fortified Breakfast cereals.



Vitamin A
Chemical Formula - C₂₀H₃₀O
PubChem ID - 445354

Figure 1: 2D structure of Vitamin A retrieved from PubChem database.

A few studies have showed that the children who had intestinal surgery or were suffering from severe kind of infections benefitted from Vitamin A supplementation.

Furthermore, Vitamin A supplementation studies on six patients with indirect measures of monocyte and macrophage function and cytokine production showed decrease in TNF alpha decrease than patients who were not taking Vitamin A supplements. More studies were conducted on HIV infected pregnant women who had no effect on the concentrations of IL-1beta in their vaginal secretions. The above trials indicated the role of Vitamin A supplementation to down regulate the secretions of certain cytokines such as TNF and IL-6 [12]. A study done on Kneyan women showed that single shot of Vitamin A had no effect in CD4 count but when Vitamin A supplementation was given daily for 6 weeks resulted in the significant increase in the CD4 counts. In extended study, the daily dose of Vitamin A for children of 3 year age resulted in increase of CD4 cells. Therefore we can draw a conclusion that Vitamin A or Pro-Vitamin A carotenoid can increase immune cells count [13]. Since HIV infection is also a viral infection which attacks the immune system of the body; Vitamin A supplementation which showed positive effect on patients infected with HIV can be further explored against COVID-19 caused by novel corona virus.

Vitamin C (Ascorbic Acid)

Vitamin C or ascorbic acid (figure 2) is a water-soluble vitamin. Immune system of the body is supported by vitamin C. Vitamin C supplementation has been able to both prevent and treat respiratory and systemic infections and improves activities of the immune system such as antimicrobial and natural killer cell activities, lymphocyte proliferation, chemotaxis, and delayed-type hypersensitivity [14]. Recent studies carried out in China and USA, showed that Vitamin C supplementation has improvement effect in the COVID -19 patients. Massive doses of Vitamin C of about 1500 milligrams were given to COVID-19 infected, while the recommended dosage is 40-60 mgs per day [15].

There are studies which demonstrated that extremely ill patients or the patients suffering from infections can tolerate really high doses of Vitamin C without any stomach upsets. Dr Robert Cathcart has supported this approach of high doses of vitamin C in very ill conditions such as pneumonia. He tested it on himself when he suffered from pneumonia. He ingested 2000 mg of Vitamin C every 6 minutes and had 100,000 mg of Vitamin C per day. He recovered really fast within hours his cough and cold went away. He recovered from Pneumonia within few days. Vitamin C also reported to have anti viral properties and it is ranked as a top most nutrient to cure viral infections [16]. The most effective form of Vitamin C is intravenous sodium ascorbate which is two and a half times more powerful than natural

ascorbic acid. This approach can be evaluated as potential COVID-19 management strategy.

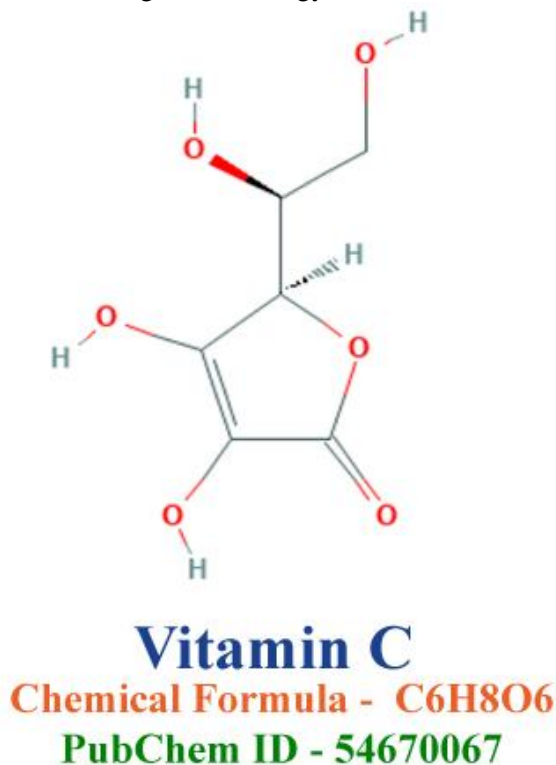


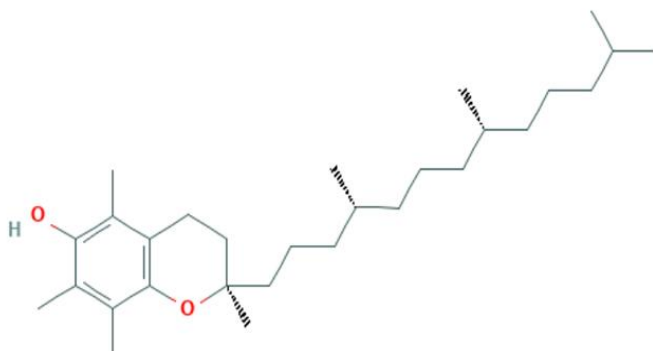
Figure 2: 2D structure of Vitamin C retrieved from PubChem database.

Vitamin C helps to strengthen the immune system by collagen synthesis enhancement, reducing the ROS and damage caused by it and also increases healing process, acting as antioxidant and increasing microbial killing through cytokines production [17-19]. Amla, Lemon, Guava, Oranges, Fruit juices and tomatoes are some of the food products rich in Vitamin C. Histamines are the modulators of Eosinophils, Basophils and mast cells. Increased levels of Histamines can be observed during stress and results in increased symptoms of allergy like flu and others, resulting in depletion of Vitamin C in body. A study was carried on guinea pigs with Vitamin C supplementation, where decrease in histamine levels thus reducing the allergy symptoms was observed [20-21]. Intervention of oral Vitamin C 125mg per day has helped to decrease histamine levels in patients having allergy symptoms [22].

Vitamin E

Vitamin E (figure 3) is a fat-soluble, potent antioxidant vitamin. Vitamin E also provides protection against air pollution, ultraviolet radiations from the sun. From a study conducted by Abbott, it was found that natural vitamin E is more effective than synthetic vitamin E. Natural vitamin E is depicted as d-alpha tocopherol or d-alpha-tocopherol on the labels of food. Natural vitamin E is found in sunflower seeds, almonds, peanuts, spinach,

asparagus, sea foods, pumpkin, broccoli, soya bean oil, and safflower oil. Vitamin E is also very helpful in maintaining human health. Vitamin E along with lutein helps in protecting Docosahexaenoic Acid (DHA) from free radicals in the body. These can be found in avocados, canola oil, olive oil, peanut oil, and nuts [7].



Vitamin E

Chemical Formula - C₂₉H₅₀O₂

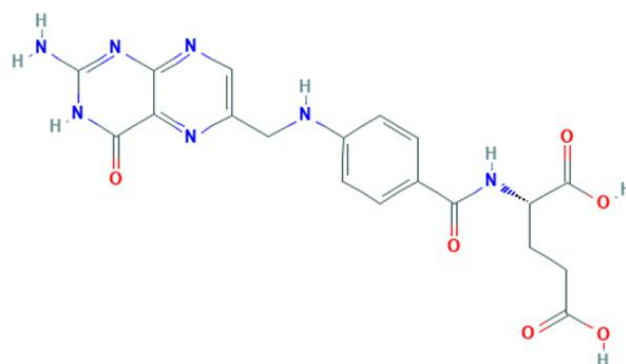
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Figure 3: 2D structure of Vitamin E retrieved from PubChem database.

In a recent study, Vitamin E showed enhancing the immunity in old aged people. Healthy elderly population were administered with 800 mg 2-*ambo-α*-tocopherol or placebo/d for 30 days and it showed increased delayed-type hypersensitivity (DTH) levels which is an indicator of cell mediated immunity. Further it was found that Vitamin E is related to increased plasma Vitamin E, DTH score and mitogenic response. In another study carried on allergic mothers with supplementation of alpha-Tocopherol resulted in decreasing allergic responses in their babies. Immune system is modulated by Vitamin E and it's observed in both animal and human based studies and plays an important key in joining innate and adaptive immunity response in human body [23].

Vitamin B₉

The synthesis of DNA and protein in the body is majorly carried out by Folate. The Vitamin B₉ or folate (figure 4) deficiency can result in decline of cell-mediated immunity. The blastogenic response of T lymphocytes to certain mitogens is decreased in folate-deficient humans and animals, and the thymus is preferentially altered. [24-25]. Whole Grains, green leafy vegetables, Liver, Sea foods and nuts are some of the foods rich in vitamin B₉. WHO in 1992 concluded that over 2 billion people worldwide suffer from Folate deficiency and then the guidelines were made to fortify the flours / breakfast cereals so that the incidence of increasing disorders from folate deficiencies can be curbed out.



Vitamin B₉

Chemical Formula - C₁₉H₁₉N₇O₆

PubChem ID - 135398658

Figure 4: 2D structure of Vitamin B₉ retrieved from PubChem database.

A study carried at Alberta University in 2008 showed the folate supplementation to a 23 months old mice increased T cell distribution and mitotic activity and when the CD4⁺ cells and T cells were measured, it was equivalent to 12 months old mice. This shows that in elderly population Folate fortification will result in better immune system [26].

Zinc

Zinc is key micronutrient which helps in normal functioning and development of the human cells which arbitrate the working of innate immunity, killer cells, macrophages and neutrophils [27]. Zinc acts as a wall to support immune system by blocking the attack of pathogens in the body. The role of nutritional immunity is carried out by Zinc in terms of host-pathogen interface. The Bacterial pathogen invasion in human body prevents Zinc acquisition and Zinc is found distributed into liver and other tissues, this leads to Zinc serum deficiency. This in turn increases response of inflammatory cytokines such as IL-1. The Zinc is considered as anti microbial; when the patients suffers nasopharynx infection, elevation in zinc to combat infection has been observed [28]. The phagocytosis, intracellular killing, and cytokine production are some of the processes which get affected in the state of zinc deficiency [29]. Grains, peanuts, fruits and green leafy vegetables are some of the food products rich in folate.

Copper

Copper is one of the essential micronutrient for the human body, especially for metabolism of iron, functioning of neuroendocrine, elasticity of lungs, cardiovascular integrity and neovascularisation. A recent research done at University of Southampton showed that copper can effectively prevent the spread of respiratory viruses. Including those which are linked to SARS and

MERS outbreaks. Application of similar strategy against COVID-19 would be a worth considering approach. Copper alloys are said to be ‘ Anti-Microbial Copper’ and it was studied that when corona virus came into its contact was inactivated within a few minutes. So according to Dr Sarah Warnes Copper utensils should be used so that the COVID-19 could not be spread through touch on the surfaces [30]. Absence of copper in body results in decreased levels of IL-2, T cell proliferation and also reduces the ability to generate superoxide anion and kill ingested microorganisms [31]. Oysters, nuts, seeds, shitake mushrooms, lobster, liver, leafy greens and dark chocolate are some of the foods which are rich source of copper.

Iron

The normal functioning of immune system and biochemical reactions in the body is completed by Iron. Iron homeostasis on the immune function and risk of infection is being studied since the 1970s. The maturation and proliferation of Immune cells such as lymphocytes is dependent on Iron availability in the serum. Not only the deficiency but also the excess of iron can affect the normal functioning of the innate and adaptive parts of the immune system. The foods rich in Iron are red meats, liver of chicken and lamb, nuts, garden cress seeds, fruits rich in vitamin C will enhance iron absorption. The Iron absorption in Vegetarians is difficult therefore we recommend the Vitamin C be accompanied by Iron rich products to increase absorption and utilization of Iron in the body. Also the decrease intake of caffeinated beverages, tea, coffee, phytates and oxalates can increase Iron absorption in the body as these foods do not allow Iron to be absorbed in the food. A study conducted on forty anemic children and children who were healthy. The full medical history was taken through clinical assessment which included CBC , Serum Iron, Serum total Iron binding capacity, Serum ferritin, immunoglobulin assay (IgA, IgG, and IgM), interleukin (IL)-6 serum level and evaluation of phagocytic function of macrophages and oxidative burst activity of neutrophils. The subjects who were given iron supplementation have a positive correlation of Iron with IL-6 serum levels. This concluded about the humoral, non-specific immunity and the role of IL-6 was influenced in Anemic patients. The Iron supplementation is strongly recommended after the study in patients suffering from Iron deficiency anaemia [32-33].

Selenium

Selenium is another micronutrient which plays a crucial role in maintenance of the human health. Deficiency of selenium has been associated with increased susceptibility to diseases caused due to

oxidative stress. Supplementation of selenium showed increased resistance to diseases and viral infections [34]. Selenium influences both the components of the immune system – innate, the non-adaptive one and acquired the adaptive one [35]. Beef, turkey, chicken, fish, shellfish, and eggs are some of the food products rich in selenium.

II. CONCLUSION

The prevalence and severity of infections is mostly dependent on the distinct immune features and with age it also changes. A common factor throughout life is the need for an adequate supply of micronutrients, which play key role in supporting immune function. Multiple micronutrient deficiencies, with the likelihood increasing with age are common throughout the world. Supplementation of essential macro and micro nutrients may help to provide basis for optimal immune functioning. The present review summarizes that micronutrients in any form can improve the disease recovery process. The deficiency of micronutrients may lead to development of many infections due to pathogens and also decrease the body’s ability to fight with life threatening infections such as COVID -19. It shall be noted that these recommendations are not to be claimed as a treatment of the COVID-19. However, with sufficient supply of macro and micro nutrients, life threatening diseases like COVID-19 could be managed well, therefore a balanced diet can increase the chances to fight back with the infections.

REFERENCES

1. Sohrabi, Catrin, et al. "World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19)." *International Journal of Surgery* (2020) doi: 10.1016/j.ijssu.2020.02.034
2. Basha, Syed Hussain. "Corona virus drugs—a brief overview of past, present and future." *Journal of PeerScientist 2.2* (2020): e1000013.
3. Birhanu Ayenew et.al. “Challenges and opportunities to tackle COVID-19 spread in Ethiopia”, *Journal of PeerScientist 2.2* (2020): e1000014.
4. Luxita Sharma. “Correlation Among The Nutritional, Mental And Physiological Factors Affecting The Health And Lifestyle Of Geriatrics Population”, *International journal of scientific & technology research*. 8.10 (2019): 2936-2948.
5. Moulin, Anne Marie. "The immune system: A key concept for the history of immunology." *History and philosophy of the life sciences* (1989): 221-236.
6. Nicholson, L. B. “The immune system”. *Essays in biochemistry*.60.3 (2016):275–301.
7. Calder, Philip C., and Samantha Kew. "The immune system: a target for functional foods?." *British Journal of Nutrition* 88.S2 (2002): S165-S176.
8. Sommer, Alfred. "Vitamin A deficiency and clinical disease: an historical overview." *The Journal of nutrition* 138.10 (2008): 1835-1839.
9. Villamor, Eduardo, and Wafaie W. Fawzi. "Effects of vitamin A supplementation on immune responses and correlation with

- clinical outcomes." *Clinical microbiology reviews* 18.3 (2005): 446-464.
10. Huang, Zhiyi, et al. "Role of vitamin A in the immune system." *Journal of clinical medicine* 7.9 (2018): 258.
 11. Ghodrati-zadeh, Soroush, et al. "Effect of carotenoid β -cryptoxanthin on cellular and humoral immune response in rabbit." *Veterinary research communications* 38.1 (2014): 59-62.
 12. Villamor, Eduardo, and Wafaie W. Fawzi. "Effects of vitamin A supplementation on immune responses and correlation with clinical outcomes." *Clinical microbiology reviews* 18.3 (2005): 446-464.
 13. Baeten, Jared M., et al. "Vitamin A supplementation and human immunodeficiency virus type 1 shedding in women: results of a randomized clinical trial." *The Journal of infectious diseases* 185.8 (2002): 1187-1191.
 14. Wintergerst, Eva S., Silvia Maggini, and Dietrich H. Hornig. "Immune-enhancing role of vitamin C and zinc and effect on clinical conditions." *Annals of Nutrition and Metabolism* 50.2 (2006): 85-94.
 15. Matthew Wright "New York hospitals are treating coronavirus patients with high dosages of VITAMIN C after promising results from China", Accessed on March 25, 2020 at <https://www.dailymail.co.uk/news/article-8149191/New-York-hospitals-treating-corona-patients-6000-milligrams-VITAMIN-C.html>
 16. Saul, Andrew W. "Nutritional treatment of coronavirus." *Orthomolecular Medicine News Service* 16.6 (2020): 22.
 17. Carr, Anita C., and Silvia Maggini. "Vitamin C and immune function." *Nutrients* 9.11 (2017): 1211.
 18. Nandi, B. K., et al. "Effect of ascorbic acid on detoxification of histamine under stress conditions." *Biochemical pharmacology* 23.3 (1974): 643-647.
 19. Subramanian N., Nandi B.K., Majumder A.K., Chatterjee I.B. "Role of L-ascorbic acid on detoxification of histamine", *Biochem. Pharmacol.* 22 (1973): 1671-1673.
 20. Dawson, W., and G. B. West. "The influence of ascorbic acid on histamine metabolism in guinea-pigs." *British journal of pharmacology and chemotherapy* 24.3 (1965): 725.
 21. Johnston, C. S., R. Elizabeth Solomon, and Corinne Corte. "Vitamin C depletion is associated with alterations in blood histamine and plasma free carnitine in adults." *Journal of the American College of Nutrition* 15.6 (1996): 586-591.
 22. Hagel, Alexander F., et al. "Intravenous infusion of ascorbic acid decreases serum histamine concentrations in patients with allergic and non-allergic diseases." *Naunyn-Schmiedeberg's archives of pharmacology* 386.9 (2013): 789-793.
 23. Lee, Ga Young, and Sung Nim Han. "The role of vitamin E in immunity." *Nutrients* 10.11 (2018): 1614.
 24. Dhur, A., P. Galan, and S. Hercberg. "Folate status and the immune system." *Progress in food & nutrition science* 15.1-2 (1991): 43-60.
 25. Iyer, Ramya, and S. K. Tomar. "Folate: a functional food constituent." *Journal of food science* 74.9 (2009): R114-R122.
 26. Daniels Stephen. "Folate Supplements could increase immunity in elderly". Accessed on March 25, 2020 at https://www.nutraingredients.com/Article/2005/12/16/Folate-supplements-could-improve-immune-system-in-the-elderly?utm_source=copyright&utm_medium=OnSite&utm_campaign=copyright
 27. Shankar, Anuraj H., and Ananda S. Prasad. "Zinc and immune function: the biological basis of altered resistance to infection." *The American journal of clinical nutrition* 68.2 (1998): 447S-463S.
 28. Djoko, Karrera Y., et al. "The role of copper and zinc toxicity in innate immune defense against bacterial pathogens." *Journal of Biological Chemistry* 290.31 (2015): 18954-18961.
 29. Shankar, Anuraj H., and Ananda S. Prasad. "Zinc and immune function: the biological basis of altered resistance to infection." *The American journal of clinical nutrition* 68.2 (1998): 447S-463S.
 30. Warnes, Sarah L., Zoë R. Little, and C. William Keevil. "Human coronavirus 229E remains infectious on common touch surface materials." *MBio* 6.6 (2015): e01697-15.
 31. Percival, S.S. "Copper and immunity", *The American Journal of Clinical Nutrition*. 67.5 (1998):1064S-1068S.
 32. Kuvibidila, S. R., et al. "The role of iron in immunity and inflammation: implications for the response to infection." *Diet, Immunity and Inflammation*. Woodhead Publishing, 2013. 193-220.
 33. Soyano, Andres, and Miguel Gomez. "Role of iron in immunity and its relation with infections." *Archivos latinoamericanos de nutricion* 49.3 Suppl 2 (1999): 40S-46S.
 34. Maggini, Silvia, Adeline Pierre, and Philip C. Calder. "Immune function and micronutrient requirements change over the life course." *Nutrients* 10.10 (2018): 1531.
 35. Hoffmann, Peter R., and Marla J. Berry. "The influence of selenium on immune responses." *Molecular nutrition & food research* 52.11 (2008): 1273-1280.

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