



Food and Nutrition in Relation to the Prevention and Treatment of COVID-19: A Review

Abolfazl Fattah¹, Sara Saadat², Fatemeh Sistani³, Mohaddeseh Badpeyma⁴, Farzaneh Fazeli⁵, Benyamin Fazli⁶, *Hamed Azadi⁷

¹Velayat Hospital, Semnan University of Medical Sciences, Semnan, Iran. ²Pediatric Nephrologist, Department of Pediatrics, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. ³Department of Nutrition, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran. ⁴Student Research Committee, Department of Clinical Nutrition, Nutrition Research Center, School of Nutrition and Food Sciences, Tabriz University Of Medical Sciences, Tabriz, Iran. ⁵Assistant Professor of Intensive Care Medicine, North Khorasan University of Medical Sciences, Bojnord, Iran. ⁶Assistant Professor of Intensive Care Medicine, Department of Anesthesiology, Mashhad University of Medical Sciences, Mashhad, Iran. ⁷Faculty of Paramedical Sciences, Ilam University of Medical Sciences, Ilam, Iran.

Abstract

Due to the lack of definitive treatment for COVID-19 so far, there is an urgent need to find alternative methods to control the spread of the disease. This study aimed to review available information on food and nutrition in relation to the prevention and treatment of COVID-19 from various sources. The studies showed that feeding during an illness is different from feeding at normal times. During an illness, in addition to meeting daily needs, attention should be paid to the changes caused by the disease in the body. These changes include loss of appetite, decreased sense of smell and taste, inability to chew and swallow, weakness, reluctance to eat certain foods, and other changes depending on the severity and duration of the illness. Therefore, in patients' nutrition, the patient's condition should be examined and their diet should be prepared according to their condition. Both in normal and emergency situations, it is necessary to observe balance and variety in the consumption of all foods. There was no information available on the association between diet and COVID-19.

The best diet recommended for patients with COVID-19 is a soft, high-protein, high-calorie diet. It is recommended to use water, juices, teas, and soups at the beginning of the symptoms. Getting all the necessary vitamins helps increase the level of immunity and fight disease and recovery through its food sources, and food sources containing vitamins and minerals have no precedence over each other. Nevertheless, given the lack of randomized controlled clinical trials of any treatment against COVID-19, medical providers have to utilize therapeutic approaches based on past, often outdated, research.

Key Words: COVID-19, Nutrition, Prevention, Treatment.

*Please cite this article as: Fattah A, Saadat S, Sistani F, Badpeyma M, Fazeli F, Fazli B, et al. Food and Nutrition in Relation to the Prevention and Treatment of COVID-19: A Review. Med Edu Bull 2021; 2(3): 287-95. DOI: [10.22034/MEB.2021.317807.1038](https://doi.org/10.22034/MEB.2021.317807.1038)

*Corresponding Author:

Hamed Azadi, Faculty of Paramedical Sciences, Ilam University of Medical Sciences, Ilam, Iran.

Email: Ha.azadi1370@yahoo.com

Received date: Jul. 05, 2021; Accepted date: Sep.22, 2021

1- INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first known case was identified in Wuhan, China, in December 2019 (1, 2). The disease has since spread worldwide, leading to an ongoing pandemic (3). The COVID-19 outbreak, one of the most challenging threats to public health at the national and international levels since December 2019 (4-7), has caused tension and fundamental changes in the daily lives of many people worldwide, especially students.

Due to the lack of definitive treatment for COVID-19 infection so far, there is an urgent need to find alternative methods to control the spread of the disease. Nutrient deficiencies lead to a decrease in the function of the immune system, which in turn can make the body more vulnerable to viral infections. The human immune system is a complex and efficient defense system consisting of cells, chemical mediators, and a series of "modular" defense factors to modulate the immune response and protect the body against external factors (8).

Malnutrition weakens the immune system by suppressing it. A balanced diet, especially with adequate vitamins, minerals, and proteins, strengthens the resistance to infections, therefore ensuring proper nutrition. Eliminating immune-related nutrient deficiencies is essential for the prevention and treatment of viral infections. There are challenges against the general public in protecting the immune system against the coronavirus. The optimal immune response depends on the adequate intake of certain nutrients. For example, adequate protein intake is critical to the optimal production of antibodies. The deficiency of micro-nutrient, such as vitamin A or zinc, can increase the risk of infection (9).

The spectrum of disease ranges from mild to severe and the symptoms include colds, fever, cough, shortness of breath, and other respiratory problems. All age groups can be affected by the virus, but seniors and people with cardiovascular diseases, hypertension, diabetes, asthma, respiratory, kidney, and liver problems, cancer patients undergoing treatment, patients taking corticosteroids for any reason, and people with a weak immune system are at higher risk for coronavirus (10, 11). Therefore, it is of utmost importance to provide care for and prevent infection in these people. Considering the complications of coronavirus infection, it is necessary to know useful nutrients to prevent and control COVID-19 disease. According to recent studies, proper diet and correction of immune-related nutrient deficiencies may be necessary to prevent and treat viral infections (8). The present study aimed to review the latest studies on effective nutritional recommendations for the prevention, treatment, and management of COVID-19.

2- MATERIALS AND METHODS

2-1. Data sources

In this review study, a systemic search of electronic databases of Medline (via PubMed), Scopus, Web of Science, ProQuest, Cochrane Library, SID, Magiran, CIVILICA, and Google Scholar search engine was performed with no time limit up to July 2021, using the following keywords alone or in combination: "Corona or Coronavirus or COVID or COVID-19" AND "Nutrient or Vitamin supplements, or Vitamin or Mineral or Macronutrient or Micronutrient or Nutritional care management or Treatment".

2-2. Inclusion and exclusion criteria

The inclusion criteria used include: (1) articles published in English or Persian up to July 2021, and (2) articles highlight the

role of nutrients in COVID-19. Meanwhile, the exclusion criteria were: (1) articles published in non-English or Persian languages, (2) articles that do not present nutrition point of view, and (3) lack of access to full-text.

2-3. Study selection

The database was searched for suitable studies, abstracts of the studies were screened for identification of eligible studies, full-text articles were obtained and assessed, and a final list of eligible studies was made. This process was done independently and in duplication by two reviewers, and any disagreement was resolved by a third reviewer. References were organized and managed using EndNote software (version X8).

3- RESULTS

Experts indicate that under both normal and emergency situations, it is necessary to observe balance and variety in a diet. Balance means consuming sufficient foods to maintain the body health, and variety refers to consuming different types of nutrients based on the Iranian food pyramid in six main food groups (bread and cereals, vegetables, fruits, milk and dairy products, meat and eggs, and legumes and nuts). Nutrients in each food group have almost the same nutritional value and can be replaced with each other. Adequate nutrient intake improves the immune system and strengthens the body's resistance to various infections, particularly COVID-19. Micronutrient deficiency can weaken the immune system and reduce the body's ability to fight pathogens (11-19). Some essential nutrients, as well as nutritional recommendations for COVID-19 prevention, during the disease period and after recovery, are provided below:

3-1. Principles of nutrition in the prevention of COVID-19

Proper nutrition and strengthening the immune system can help prevent disease. Adherence to instructions will help increase the body's immune system under specific situations:

- To increase the level of body immunity, sources of vitamin C should be used, including fruits and vegetables, especially green leafy vegetables and cabbage, cauliflower, tomatoes, wheat germ, citrus fruits, kiwi, and other available fruits on a daily basis.
- As uncooked onion contains vitamin C, it can be used daily along with meals.
- Turnips, which contain vitamin C, can be used in soups or stews.
- Considering the role of vitamins A and E in strengthening the immune system, sources of these two vitamins should be used on a daily basis.
- Fatty and salty foods such as salty snacks, canned foods and sausages, oily and fried foods should be avoided since they stimulate the immune system.
- Foods rich in vitamin D (fatty fish, dairy, and egg yolk) help boost the immune system.
- Sources of iron and zinc (liver, red meat, chicken and fish, eggs, vegetables, fresh and dried fruits, nuts and legumes) should be taken on a daily basis.
- Sources of B vitamins such as green leafy vegetables and fruits, milk and dairy products, meats and egg yolk, whole grains, legumes such as peas and beans, lentils, fava beans, and nuts (pistachios, walnuts, hazelnuts, almonds, and peanuts) should be taken to boost the immune system on a daily basis.
- It is recommended to drink six to eight glasses of clean drinking water or other liquids daily.
- Drinking plenty of fluids helps maintain a healthy immune system.

- Eating out should be avoided. Outdoor meals may not be prepared based on proper hygiene and have high amounts of saturated and Trans fat and salt, which weaken the immune system.

3-2. Nutrition during the COVID-19 pandemic

Nutrition during the COVID-19 pandemic should be different from normal conditions. In this period, in addition to meeting daily needs, disease-related body changes should be considered, including loss of appetite, decreased or loss of sense of smell and taste, inability to chew and swallow, physical weakness, reluctance to eat certain foods, and other changes depending on the severity and duration of the disease. Therefore, the patient's condition should be examined and their diet plan should be prepared accordingly. Although it is best to plan the patient's diet by a nutritionist, general advice to patients can be helpful in the absence of nutrition and diet counseling services. This section provides general recommendations regarding the nutrition of COVID-19 patients.

The most recommended diet for COVID-19 patients is a soft, high-protein, high-calorie diet. However, this diet is planned for patients who can chew and swallow, and special diets are used for critically-ill patients. In general, drinking enough fluids is an effective step in controlling the disease. Water, juices, teas, and soups are recommended fluids at the onset of symptoms. Digestion of liquid compounds requires less energy, so the body will have more energy to fight disease. Fluids help dilute secretions and eliminate toxins and relieve sore throats. Another important measure is the adequate intake of essential micronutrients for the immune system such as vitamins C, B6, E, D, zinc, magnesium, selenium, and omega-3, especially from food sources rich in these compounds. Immune system cells, for

example, are rich in vitamin C, and the supply of vitamin C to the affected cells increases under stressful conditions, which in turn increases the need for vitamin C during infection and inflammation. Experts believe that vitamin C plays an important role in strengthening the immune system and preventing and controlling the disease.

3-3. Nutrition after recovery from COVID-19

Following the infection, patients lose appetite while requiring more nutrients. Therefore, the patient may suffer from malnutrition. During the recovery period, the appetite increases and there is time to compensate for the nutrient deficiencies and an appropriate diet can be planned to meet nutritional needs during the recovery period.

3-3-1. Recommendations for the diet of people who are recovering from COVID-19 disease:

- Supplying large amounts of fluids such as clean drinking water, natural fruit juices, fresh vegetable juices, and light tea at least eight glasses per day.
- Warm, light, and non-bloating soups.
- Daily consumption of fresh fruits and vegetables.
- Use of food sources of vitamin A and vitamin C.
- Use of food sources containing protein, zinc, iron, and selenium, which strengthen the immune system.
- Use of liquid vegetable oils instead of animal oils.
- Balanced use of honey mixed with warm liquids to strengthen the immune system and ease coughs.
- Use of turmeric in food because of its anti-inflammatory properties.

- Adding adequate amounts of garlic, onion, and ginger to food to strengthen the immune system.
- Use of ginger and banana for those who have nausea.
- Regular consumption of all main meals, especially breakfast and two to three snacks during the day to provide enough energy.

3-3-2. Dietary restrictions during COVID-19 recovering:

- Heavy and processed food such as pasta, sausages, and hot dogs.
- Fatty and fried food.
- Fast food products.
- Pickles and vinegar that cause dryness and irritation of the respiratory tract.
- Salt, and canned foods high in salt.
- Peppers, spicy sauces, and mustard.
- Sugars, carbonated drinks, industrial juices with added sugar, syrups, and sweets.
- Spicy and stimulating drinks such as coffee, strong tea, and Nescafe.
- Animal fats such as butter, cream, tallow, and full-fat dairy (11-19).

3-4. Essential substances for the body

In a meta-analytic study, it was suggested that vitamin D deficiency may increase the risk of hospitalization and mortality in COVID-19 patients (20). The results of a review by Taqdir et al. showed that deficiency of some nutrients weakens the immune system. Adequate intake of vitamins (A, D, B group, E, and C), minerals (selenium, zinc, and iron), and long-chain omega-9 fatty acids from the diet is essential for proper immune function. Therefore, it is recommended to follow a proper diet to prevent COVID-19. The authors also suggested that the

nutritional status of COVID-19 patients should be evaluated and that appropriate supplementation should be considered based on the results of the experiments (21). The results of a study by Ramezani et al. showed that considering the role of nutrition in preventing infections and the relationship between vitamins and minerals deficiency and exacerbation of respiratory diseases, all patients should be advised to eat a lot of fruits and vegetables. Consumption of warm fluids to dilute respiratory secretions and having a varied balanced diet that includes all major food groups are important for these patients. For people with nutritional deficiencies, supplementation is recommended; however, there are contradictory findings among patients (22). The results of a review study by Bahr Al-Olom et al. showed that micro- and macronutrients such as vitamins and minerals such as zinc, iron, selenium, and copper, proteins, and long-chain fatty acids such as omega-3 play an important role in boosting immune function and increasing resistance to respiratory infections such as COVID-19 (23).

The results of Calder's review study showed that some vitamins (A, B6, B12 and folate, C, D, and E), and trace elements (Zinc, Copper, Selenium, Iron) have a key role in supporting the human immune system and reducing risk of infections. Other essential nutrients such as other vitamins and trace elements, amino acids and fatty acids are also important (24). In a two-month prospective observational study on 1,083 adults admitted in less than 24 hours to a tertiary-care hospital, Chada et al. found that the mortality rate was significantly higher in those suffering from inadequate calorie and protein delivery than other ICU patients ($p < 0.001$). This study showed that the optimization of daily nutrient delivery, surpassing interruptions, can improve the conditions of COVID-19 and

it can be considered as a desired standard of care (25). A review by Thibault et al. showed that providing optimized nutrition for COVID-19 patients in the intensive care units is effective in maintaining gastrointestinal tract function, sustaining immune defenses, and preventing large losses of muscle mass and function (26).

The results of Omar's review showed that nutrition management in ICU patients infected with COVID-19, vitamin supplements on COVID-19, and the comorbidity spectrum of nutrition-related conditions and their impact on the outcome of COVID-19 treatment remain largely unknown (27). According to Khayyatzadeh's opinion, no information is available on the association between diet and COVID-19 although it was recommended that all people consume varied and healthy food rich in immunoregulating nutrients. Furthermore, some nutrient supplementations such as vitamin C, vitamin E, selenium, and Zinc may have beneficial effects on COVID-19 patients (28).

The role of vitamin C in the prevention and treatment of patients with coronavirus has been noted widely across the world (29-31). In their review study, Che Abdul Rahim et al. suggested that there was no concrete proof on the effect of vitamin C against COVID-19. Further research is required to determine the exact dosage of vitamin C and its mechanism of action in the treatment of COVID-19 (32).

Five studies have noted the effect of vitamin D on COVID-19 (33–37). Che Abdul Rahim et al. believe further studies on vitamin D should be performed using randomized controlled trials and large populations to support the effectiveness of vitamin D in treating COVID-19 (32). Also, five studies have suggested specific vitamins, such as vitamins A, B, and E, and trace elements to treat COVID-19 (33, 38–41). In another study, vitamin B3 was claimed to have lung-protecting effects;

therefore, it should be used when COVID-19 patients develop cough (40). Eight studies reported that other micronutrients and minerals, such as magnesium, zinc, selenium, folic acid with furin, and flavonoids have positive effects on viral infections (37, 39, 41–46).

4- CONCLUSION

To strengthen the immune system and fight diseases such as COVID-19, it requires modifying the nutrition and having a healthy diet rich in nutrients. Good nutrition is very important before, during and after an infection. Therefore, maintaining a healthy diet is very important during the COVID-19 pandemic. While no foods or dietary supplements can prevent COVID-19 infection, maintaining a healthy diet is an important part of supporting a strong immune system. Experts indicate that under both normal and emergency situations, it is necessary to observe balance and variety in a diet. Balance means consuming sufficient foods to maintain the body health, and variety refers to consuming different types of nutrients based on the Iranian food pyramid in six main food groups (bread and cereals, vegetables, fruits, milk and dairy products, meat and eggs, and legumes and nuts). Adequate nutrient intake improves the immune system and strengthens the body's resistance to various infections, particularly COVID-19. Micronutrient deficiency can weaken the immune system and reduce the body's ability to fight pathogens.

5- AUTHORS' CONTRIBUTIONS

Study conception or design: AF, SS, and HA; Data analyzing and draft manuscript preparation: SS, FS, MB, FF, and BF; Critical revision of the paper: AF, and SS; Supervision of the research: AF and HA; Final approval of the version to be

published: AF, SS, FS, MB, FF, BF, and HA.

6- CONFLICT OF INTEREST: None.

7- REFERENCES

1. Page J, Hinshaw D, McKay B. "In Hunt for Covid-19 Origin, Patient Zero Points to Second Wuhan Market – The man with the first confirmed infection of the new coronavirus told the WHO team that his parents had shopped there". The Wall Street Journal. Retrieved 27 February 2021.
2. Ghodsi A, Azarfar A, Ghahremani S. A Review of Coronavirus Disease (COVID-19) in Children. *Journal of Pediatric Nephrology*. 2020; 8(3):1-6.
3. Zimmer C. "The Secret Life of a Coronavirus – An oily, 100-nanometer-wide bubble of genes has killed more than two million people and reshaped the world. Scientists don't quite know what to make of it". Retrieved 28 February 2021.
4. Nutrition advice for adults during the COVID-19 outbreak. Available at: <http://www.emro.who.int/nutrition/news/nutrition-advice-for-adults-during-the-covid-19-outbreak.html>.
5. Ghodsi A, Malek A, Ghahremani S. A Review of Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with COVID-19. *Hormozgan Med J*. 2020 December; 24(4):e107048.
6. How to boost your immune system. Feb 15, 2021. <https://www.health.harvard.edu/staying-healthy/how-to-boost-your-immune-system>.
7. Ghodsi A, Sarabi M, Malek A, Khakshour A. Current Treatment Guidelines of SARS-CoV-2 Related Multisystem Inflammatory Syndrome in Children: A Literature Review and Expert Opinion. *J Child Sci* 2021; 11:e133–e140.
8. BourBour F. Nutrients in prevention, treatment, and management of viral infections; special focus on Coronavirus. *Arch Physiol Biochem*. 2020;1-10. doi: 10.1080/13813455.2020.1791188
9. Iddir M, Brito A, Dingeo G, Fernandez Del Campo SS, Samouda H, La Frano MR, et al. Strengthening the Immune System and Reducing Inflammation and Oxidative Stress through Diet and Nutrition: Considerations during the COVID-19 Crisis. *Nutrients*. 2020;12(6). doi: 10.3390/nu12061562 pmid: 32471251.
10. Akef, E., Eslahtalab, A., Dehghani, N., Mardani, E. A Reflection on the Situation of Coronavirus Vaccination in Iran and Turkey. *Medical Education Bulletin*, 2021; 2(2): 207-210. doi: 10.22034/meb.2021.301943.1023.
11. Coronavirus Nutrition Management Guide (COVID-19). Deputy Minister of Health, Office of Community Nutrition Improvement. Ministry of Health; 2019.
12. Healthy nutrition in the prevention and treatment of coronavirus. West Azerbaijan University of Medical Sciences, Deputy of Health. Principles of nutrition in the prevention of COVID-19; 2020.
13. Guidance for Nutrition Management of Covid-19 for Health Workers in Covid-19 Treatment and Isolation Centers.
14. Eat Right During COVID-19: Food Hygiene, Safety and Nutrition Guidelines for Consumers to Prevent the Spread of Coronavirus. (Uploaded on: 07.06.2020)
15. World Health Organization (WHO), Coronavirus disease (COVID-19) advice for the public. Available on: <https://www.WHO.Int/emergencies/diseases/novel-coronavirus2019/advice-for-public>. Feb 2020.
16. Food and Agriculture Organization of the United Nations (FAO), Coronavirus disease (COVID-19) outbreak. Available on: <http://www.FAO.Org/2019-ncov/en/>. Feb 2020.
17. Ross AC, Calallero B, Cousins RJ, Tucker KL, Ziegler TR, editors. *Modern Nutrition in Health and Disease*. 11th ed. Baltimore, MD: Lippincott Williams & Wilkins; 2014.
18. Nathaniel Bergmon, David S Riley, Michelle Badalschies, *BMJ journal*, Diet and lifestyle recommendation for treatment of cough and chronic disease.
19. Kraus, *Food and Nutrition Therapy* 12th Edition. ISBN-13: 978-1416034018.

20. Pereira M, Dantas Damascena A, Galvão Azevedo LM, de Almeida Oliveira T, da Mota Santana J. Vitamin D deficiency aggravates COVID-19: systematic review and meta-analysis. *Crit Rev Food Sci Nutr*. 2020 Nov 4;1-9. doi: 10.1080/10408398.2020.1841090. Epub ahead of print. Update in: *Crit Rev Food Sci Nutr*. 2021 Aug 12;:1-6. PMID: 33146028.
21. Taghdir M, Sepandi M, Abbaszadeh S, Parastouei K. A review on some Nutrition-Based Interventions in Covid-19. *J Mil Med*. 2020; 22 (2) :169-76.
22. Ramezani A, Amirpour M. Nutritional Care in the Prevention and Treatment of Coronavirus Disease 2019: A Simple Overview. *J Health Res Commun*. 2020; 6 (1): 74-82.
23. Bahrulolum H, Nooraei S, Entezari M, Hashemi M, Houshmandi K, Raei M. The role of nutrition and nutritional factors in the prevention and treatment of COVID19: a review study. *EBNESINA*. 2020; 22 (3): 56-66.
24. Calder PC. Nutrition, immunity and COVID-19. *BMJ Nutrition, Prevention & Health* 2020;3: e000085. doi:10.1136/bmjnp-2020-000085.
25. Chada RR, Chidrawar S, Siddiqua A, Medanki R, Omer SA, Nagalla B. Tailoring nutrition therapy amid the COVID-19 pandemic: Does it work? *Clin Nutr ESPEN*. 2021 Oct;45:381-388. doi: 10.1016/j.clnesp.2021.07.015. Epub 2021 Jul 23. PMID: 34620344; PMCID: PMC8299140.
26. Thibault R, Seguin P, Tamion F, Pichard C, Singer P. Nutrition of the COVID-19 patient in the intensive care unit (ICU): a practical guidance. *Crit Care*. 2020 Jul 19;24(1):447. doi: 10.1186/s13054-020-03159-z. PMID: 32684170; PMCID: PMC7369442.
27. Mariam Omar, Salima Elfagi, Faiza Nouh. Covid-19 and Nutrition: Review of Available Evidence. *Scholars Journal of Applied Medical Sciences*, 2020;1158-64. doi: 10.36347/sjams.2020.v08i04.025.
28. Khayyatzadeh SS. Nutrition and Infection with COVID-19. *Journal of Nutrition and Food Security (JNFS)*, 2020; 5 (2): 93-96.
29. Taylor PA. Chinese medical team report successful treatment of coronavirus Patients with high-dose vitamin C [Internet]. Netherlands: Dr Rath Health Foundation; 2020 [Retrieved 2020 Mar 22]. Available at: <https://www.dr-rath-foundation.org/2020/03/chinese-medical-team-report-successful-treatment-of-coronavirus-patients-with-high-dose-vitamin-c/>.
30. Andrew WS. Vitamin C protects against coronavirus. *OMNS* [Internet]; 2020 [Retrieved 2020 Mar 17]. Available at: http://orthomolecular.org/resources/omns/v16n04_shtml.
31. Hemilä H, Chalker E. Vitamin C may reduce the duration of mechanical ventilation in critically ill patients: a meta-regression analysis. *J Intensive Care*. 2020;8:15. <https://doi.org/10.1186/s40560-020-0432-y>
32. Che Abdul Rahim N, Manjit Singh JS, Pardi M, Zainuddin AA, Salleh R. Analysis of available nutrition recommendations to combat COVID-19: a scoping review. *Malays J Med Sci*. 2021;28(3):18-45. <https://doi.org/10.21315/mjms2021.28.3.3>.
33. Zhang L, Liu Y. Potential interventions for novel coronavirus in China: a systematic review. *J Med Virol*. 2020;92:479-490. <https://doi.org/10.1002/jmv.25707>.
34. Grant WB, Lahore H, McDonnell SL, Baggerly CA, French CB, Aliano JL, et al. Evidence that vitamin D supplementation could reduce risk of influenza and COVID-19 infections and deaths. *Nutrients*. 2020;12:988. <https://doi.org/10.3390/nu12040988>.
35. Frieden T. Former CDC Chief Dr Tom Frieden: coronavirus infection risk may be reduced by vitamin D. *Latest News* [Internet]; 2020 Mar 23 [Retrieved 2020 Apr 1]. Available at: <https://www.foxnews.com/opinion/former-cdc-chief-tom-frieden-coronavirus-risk-may-be-reduced-with-vitamin-d>.
36. McCartney DM, Byrne DG. Optimization of vitamin D status for enhanced immunoprotection against Covid-19. *Ir Med J*. 2020;113(4):58.
37. Andrew WS. Nutritional treatment of coronavirus [Internet]. *Orthomolecular*

Medicine News Service; 2020 [Retrieved 2020 Apr 8]. Available at:

38. Basiri M. Theory about treatments and morbidity prevention of coronavirus disease (COVID-19). *J Pharm Pharmacol.* 2020;8(3). <https://doi.org/10.17265/2328-2150/2020.03.004>.

39. Calder PC, Carr AC, Gombart AF, Eggersdorfer M. Optimal nutritional status for a wellfunctioning immune system is an important factor to protect against viral infections. *Nutrients.* 2020;12(4):1181. <https://doi.org/10.3390/nu12041181>.

40. Shi Y, Wang Y, Shao C, Huang J, Gan J, Huang X, et al. COVID-19 infection: the perspectives on immune responses. *Cell Death Differ.* 2020;27:1451–54. <https://doi.org/10.1038/s41418-020-0530-3>.

41. Gombart AF, Pierre A, Maggini S. A review of micronutrients and the immune system—working in harmony to reduce the risk of infection. *Nutrients.* 2020;12(1):236. <https://doi.org/10.3390/nu12010236>.

42. Editorial Review Board. Rationale for vitamin C treatment of COVID-19 and other viruses. *OMNS* [Internet]; 2020 [Retrieved 2020 Apr 1]. Available at: <http://orthomolecular.org/resources/omns/v16n21.shtml>.

<http://www.orthomolecular.org/resources/omns/v16n06.shtml>.

43. Luke C. Antiviral foods disease coronavirus [Internet]. *Indian Express*; 2020 Mar 16 [Retrieved 2020 Mar 27]. Available at: <https://indianexpress.com/article/lifestyle/health/anti-viral-foods-diseases-coronavirus-6248938/>.

44. Sheybani Z, Dokoohaki MH, Negahdaripour M, Dehdashti M, Zolghadr H, Moghadami M, et al. The role of folic acid in the management of respiratory disease caused by COVID-19. *ChemRxiv.* 2020. <https://doi.org/10.26434/chemrxiv.12034980.v1>.

45. Meneguzzo F, Ciriminna R, Zabini F, Pagliaro M. Accelerated production of hesperidin-rich citrus pectin from waste citrus peel for prevention and therapy of COVID-19. 2020; Pre-prints. <https://doi.org/10.20944/preprints202003.0386.v1>.

46. Courtenay A. COVID-19/Coronavirus and nutrition. South Africa: Shaw Academy; 2020 [Retrieved 2020 Mar 30]. Available at: <https://blog.shawacademy.com/covid-19-coronavirus-and-nutrition-by-abby-courtenay/>.