A Review on Boosting Immune System By Healthy Lifestyle

By

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A thesis submitted to the school of Pharmacy in partial fulfillment of the requirements for the degree of Bachelors of Pharmacy

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Declaration

It is hereby declared that

1. The thesis submitted is my original work while completing my degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material that has been accepted or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Approval

The thesis/project titled "A review on boosting the immune system by healthy lifestyle" submitted by Mojibul Hasan (ID-17346048) in Spring 2017 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelors of Pharmacy on 26th May 2022.

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Ethics Statement

The thesis was done without unethical work. No human or animal tests are involved in this study.

Abstract

The Covid-19 pandemic is now a major global problem. So we must improve our immune system against all diseases. Researchers found various immune system boosters. This research discusses keeping a healthy lifestyle to enhance the immune system. This discussion's material came from WHO recommendations and numerous publications and articles. A healthy lifestyle includes eating nutritious foods, exercising regularly, and other factors. The ideal proper nutrition is a perfect balance of carbs, proteins, vitamins, and minerals. Physical exercise keeps the body in shape. Sleep, smoking, consuming alcohol, and other lifestyle variables also impact the human body. Therefore, the readers will know how to maintain a healthy lifestyle and a robust immune system.

Keywords: Covid-19; Immunity; Vitamin; T-cell; Disease; Lifestyle.

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List of Acronyms

SARS-CoV-2= Severe Acute Respiratory Syndrome Coronavirus-2.

PHEIC= Public Health Emergency of International Concern.

HIIT = High-intensity interval training.

TCR= T-cell receptors.

HSV=Herpes Simplex Virus.

CRF = Corticotropin-releasing factor.

URTI= Upper respiratory tract infection.

MET =Metabolic Equivalent of Task.

NK = Natural killer.

ACE= Angiotensin-converting enzyme.

TB= Tuberculosis.

MERS= Middle East respiratory syndrome.

IL-2= Interleukin-2.

TNF= Tumor necrosis factor.

ARDS= acute respiratory distress syndrome.

Chapter 1

Introduction

A healthy immune system is critical to our survival. Bacteria, viruses, parasites, and other microorganisms might easily infect humans if we didn't have an immune system. In a sea of germs, it is our immune systems that protect us from suffering from the disease. As soon as an invasion has been detected, a comprehensive response is launched by this network of cells and tissues. Different kinds of cells, tissues, and organs are involved in the immune system, which is distributed throughout the body. To be most important, it can differentiate between our tissue and that of other organisms. Additionally, Cells that have died or are faulty are recognized by the immune system and eliminated. To combat an invading disease, the body's immune system performs an immunological response (Rhoades & Tanner, 2003). Immunity is divided into two types based on reaction time. Because of their interaction, these responses are intrinsic and adaptive. However, most people use the word "innate immunity" to refer to immune system components that give immediate host protection. Its involvement in survival is characterized by its sustained response. Adaptive immunity is found in higher animal immune systems. The response comprises antigen-specific T and B cells. Unlike the inherent reaction, the adaptive response takes days or weeks to develop. The adaptive reaction is greater with repetition, but it takes time (Kellie & Al-Mansour, 2017).

In the last two years, the world is facing a new health challenge. The new infectious coronavirus illness of 2019 (COVID-19) pandemic is caused by SARS-CoV-2 and presents a global threat; its eventual scale is unknown. COVID-19 is likely to persist and recur in waves like the influenza epidemic in 1918 (Lange & Nakamura, 2020). The WHO declared it a pandemic in 2020. World

Health Organization got its first report of pneumonia with severe and rapid fatalities in Wuhan, China, on December 31st. In the wake of a new viral outbreak, coronavirus disease 2019 (COVID-19), a new virus, SARS-CoV-2, has been revealed as the source (Monye & Adelowo, 2020b). Since COVID-19 is extremely contagious, the virus has spread throughout the nation and the globe as a consequence of its human-to-human transmission and highly infectious nature during Chinese New Year festivities (Yousfi et al., 2020). Covid-19 is a virus with an enveloped single-stranded RNA genome. Coronaviruses infect animals from bats to humans, producing respiratory illnesses (Khabour & Hassanein, 2021). Both the "L type" (70%) and the "S type" (30%) of SARS-CoV-2 are infectious and aggressive. In confirmed cases, roughly 80% of patients have mild or moderate symptoms, 13% have significant outcomes, and 6% have critical signs, with older people (>60 years) having a higher risk of severe illness (Shakoor et al., 2021).

Currently, no cure exists for COVID-19. These include social distancing, public hygiene, and face masks. Only our immune system can stop Novel Coronavirus 19 from spreading in a pandemic. The WHO has also suggested taking certain minerals to stay healthy throughout the pandemic (Mishra & Patel, 2020). Emerging evidence suggests nutritional supplements may aid COVID-19 sufferers. The FDA advises increased dosages of vitamins, zinc, and omega-3 fatty acids for SARS-CoV-2 patients (Hemilä & Chalker, 2019). These minerals are immunomodulatory in addition to antioxidant. Deficiencies in some nutrients can weaken the immune system, making you more prone to illness and disease. Obesity and malnutrition have been linked with COVID-19 patients, especially the elderly. Anticipating the unfavorable consequences of COVID-19 requires anticipating dietary inadequacies and immune system weakness in elderly people. SARS-CoV-2 has been linked to vitamin, mineral, and omega-3 fatty acid deficiencies (Grant et al., 2020). Immune cells require sufficient macro- and micronutrients to develop, articulate, and maintain an immune response, respectively. Popularity of antioxidant-rich diets has prompted studies on the influence of various nutrients on immune function (Maggini et al., 2008). Immune cells create a microenvironment to fight viruses and bacteria. Maintaining a healthy immune system is essential to avoiding illness. It's critical to get the necessary number of vitamins and minerals daily. Viruses, particularly HIV, destroy cellular immune system components, impairing protective immunological responses. The fact that multiple COVID-19 risk factors are associated to reduced immunity is clinically significant. Obese people, diabetics, and those with liver illness are more susceptible to SARS-CoV-2 infection (Razzaque, 2020). Vitamins are powerful antioxidants that help skin epithelial function. Every nutrient is required for antibody production. The innate and adaptive immune systems require vitamins to grow properly. Our bodies use vitamins to enhance the production of cytokines and T cells (Farhan Aslam et al., 2017).

In addition, Regular exercise improves health and reduces the risk of systemic inflammation and cellular immune response (da Silveira et al., 2021). Regular exercise increases lymphocytes, NK cells, immature B cells, and monocytes. Consistent physical activity increases immunity, prevents respiratory diseases and hence protects against infections like COVID-19 (Nieman, 2020). Exercising mice improved immunity Keeping mice on a treadmill daily to avoid moderate electric shocks. One of the three control groups got both shock and exercise. With syngeneic tumor cells, the exercised animals showed a better plaque-forming cell response and slower tumor development (Fitzgerald, 1988).

Sleep is also essential for the body's immune system. Predictably, a recent poll indicated that roughly a third of Americans had at least one sleep concern. Sleep deprivation is a typical complaint among psychiatric populations, such as those with severe depressive illness. Research has indicated that sleeplessness increases the risk of infection and inflammation as well as depression and overall mortality. Sleep disorders like insomnia have been linked to unfavorable health outcomes, and understanding the molecular mechanisms might assist identify those at risk for early intervention and morbidity prevention (Irwin & Opp, 2017).

As a result, the purpose of this article is to conduct a comprehensive analysis of the topic of Boosting the immune system by a healthy lifestyle. The bibliographic study contained material on nutrition, physical activity's effects on the immune system, and behaviors that affect it, as well as the latest research on a healthy lifestyle and how it relates to the immune system of the host.

Chapter 2

Immune System

The immune system protects your body against toxins, infections, and cell abnormalities that might lead to sickness. The structure of the body is comprised of organs, cells, and proteins. Infection and other diseases may be prevented through a network of cells, tissues, organs, and the substances they create. When it comes to our bodies' immune systems, white blood cells and lymph system organs and tissues are among the most important (Rhoades & Tanner, 2003).

The immune system protects us from harmful toxins. The human body has several protection systems. One of the essential elements of creatine on the skin. The body's biochemical units are also considered. Non-specific molecules like neutrophils and macrophages help host phagocytes fight infections. Many of these molecules adhere to the surface of phagocytes and lymphocytes, triggering the creation of interferon, interleukin, and other immune system activators (Karacabey, 2012). A robust immune system is required for good health. Dysfunction can lead to a wide spectrum of illnesses. The innate and adaptive immune systems are essential to the body's defenses.

Innate defense systems include nonspecific phagocytic leukocytes and serum proteins (Simon, 1984). The adaptive system, comprised of T and B cells, is triggered when pathogens that have escaped these early barriers are encountered. When this process is activated, some cells may detect microbes. With each subsequent exposure to the pathogen, the adaptive system becomes more comprehensive and effective adaptive defense mechanisms. They act as a key barrier to the propagation of infectious diseases and their long-term persistence (Rhoades & Tanner, 2003).

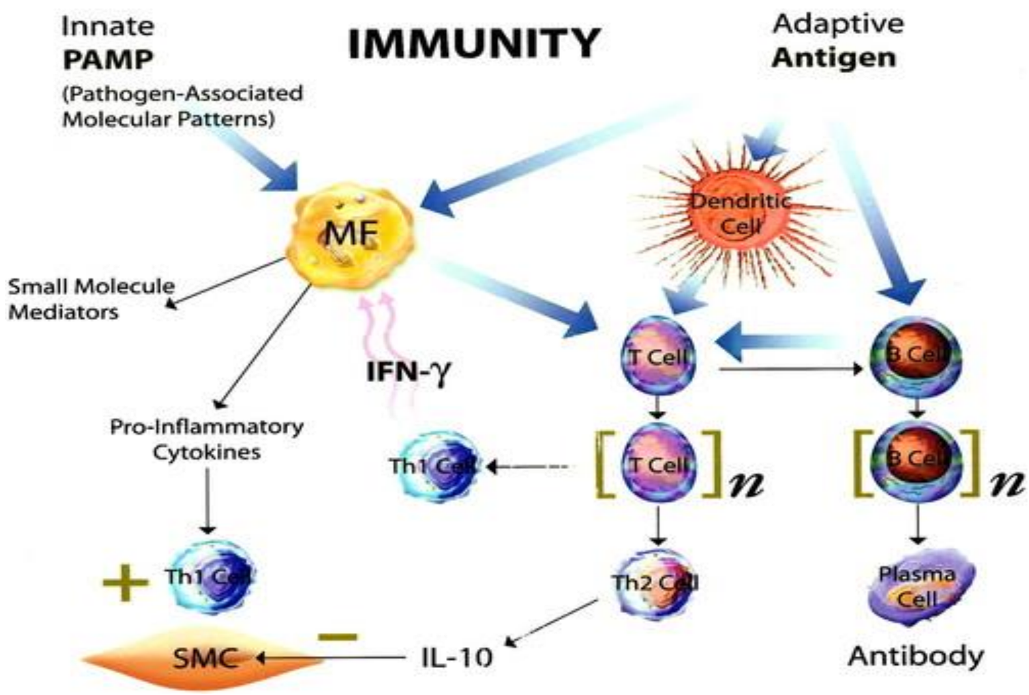

Figure 1: Immune System of human body (Hansson et al., 2002).

Your skin is your first line of protection against sickness. Pathogenic organisms can enter the body through natural cavities and glands. Enzymes and secretory immunoglobulins provide defense. The lungs and stomach also block blood flow to these organs. The alveolar macrophages and low pH of these organs protect against further invasion (Rhoades & Tanner, 2003). This nonspecific system, which lines the sinusoids and blood vessels of immune system organs including the spleen, liver, and bone marrow, further weakens the invading organisms. Toxins in the circulation trigger an inflammatory cascade. Affected areas receive more blood flow when blood proteins and cells interact with infections. Inflammation is characterized by four common signs: rubor (redness), calor (heat), tumor (edema), and dolor (pain) (Brolinson & Elliott, 2007). This response helps the inflammatory process expand to the cellular level by enhancing immune system trafficking. Larger molecules may permeate the endothelium due to increased capillary permeability. These compounds frequently aid in the removal of invaders or increase the inflammatory response (Rhoades & Tanner, 2003). The immune system contains polymorphonuclear leukocytes, phagocytes, chemotactic factors, and complements. Then come inflammatory mediators such free radicals and granular enzymes that cause cell death. T-cells can also kill viruses and malignant cells. These large granular lymphocytes stop invaders from developing and spreading. In vivo, these processes are intricately interconnected and only operate correctly when connected.

The adaptive system protects itself against invaders in three ways. Identifying pathogen antigenic markers is the initial step. Second, the host organisms may provide a molecular and cellular attack against the invaders. This fatal trio is accomplished by the adaptive system's antibodies, T lymphocytes, and B cells remembering previous intruders. These cells conduct adaptive system identification, response, and memory functions (Akiyama et al., 2021). Clonal selection is the initial stage in this complicated process. Once a B cell's receptors identify an antigen, a generation of B and T cells (specific for the inducing antigen) are generated. In the course of their development, these offspring B cells may either become plasma cells that make antigen-specific antibodies or memory cells that monitor recognition. As these cells multiply, so does resistance to disease (Rhoades & Tanner, 2003). A cellular or humoral resistance against infection is mounted by the body after exposure to one of these illnesses. T and B cells, as previously established, mediate immune system responses. T cells are important in cellular immunity (Brolinson & Elliott, 2007). However, these cells don't produce antibodies. Instead, they develop specialized cells preprogrammed to do certain functions. Helper T lymphocytes lyse or suppress germs, whereas cytotoxic T lymphocytes kill pathogens. T cells can also release cytotoxic or immunomodulatory cytokines like TNF and interleukin 2 (Akiyama et al., 2021). Less than 24 hours after first antigen exposure, the B cell line is activated. The tuberculin pure protein derivatives test may indicate this type of response. To reject donor tissue grafts and kill cancer cells, T-cell-mediated immune responses are required. In persons with HIV/AIDS, T-cell depletion can be deadly (Brolinson & Elliott, 2007). The humoral reaction is controlled by the B cell. It is possible for plasma cells to produce antigen-specific antibodies. In addition to antibodies and immunoglobulins, other bodily fluids including saliva and serum include these protective substances. They can be classified by size, structure, and function. Immunoglobulins are diverse. Immunoglobulin G is the most prevalent antibody in serum to fight against bacteria and other disease-causing diseases (IgG). Serum, tears, colostrum, and mucus include secretory immunoglobulins (IgA). A lot of it comes from the mouth. Anti-infection IgM is produced shortly after an antigenic assault. It also binds and releases allergen- and anaphylactic-allergic mediators, such as mast cells and basophils. Anaphylaxis is a life-threatening allergic response. Unlike the T cell, antibodies can cause an immediate hypersensitivity reaction. Anaphylactic reactions occur when a mast cell-bound antibody responds with a mast cell antigen (Rhoades & Tanner, 2003). Histamine as well as leukotrienes are released by the mast cell. Immune complexes that activate the plasma complement system have a quick impact (CCS). Enzyme activation causes edema, chemotaxis , and changes in the immediate inflammatory environment (Akiyama et al., 2021).

As a result, the immune system is built like the nervous system. An immune system must be able to distinguish amongst a million threats to be effective. This property permits the immune system's functionary cells to recognize and recall new things (Karacabey, 2012). The combination of innate and adaptive immune systems offers a complete mechanism for preventing and killing pathogens.

Chapter 3

Role of food and nutrition on boosting the immune system

Every year, six million children die from illnesses caused by a weakened immune system caused by malnutrition. As a result, we must eat enough food. A healthy immune system requires a diet rich in protein, especially dairy products like milk and eggs. Dietary sources of vitamins C and E, as well as foods high in beta-carotene, are recommended for protection against free radicals. Free radicals are vital for human health and only pose a concern when overexposed (Karacabey, 2012).

Immune system support is essential for maintaining proper health after the COVID-19 pandemic. "Prevention is better than cure" holds true here. If COVID-19 isn't yet curable with medicine, it's fine to use preventative immune-boosting activities. Dietary choices impact immunity and overall health. Cutting carbs may assist with blood sugar and blood pressure control. Diabetics should consume a diet strong in protein and low in carbohydrates. Eat enough beta-carotene, vitamin C, and other nutrients (Mishra & Patel, 2020). A low-fat, plant-based diet may help the immune system. In the immune system, WBCs produce antibodies that help fight germs and viruses. Vegetarians have superior white platelets than non-vegetarians due to increased nutritional consumption and reduced fat intake. A low-fat diet may also help. Reduced fat intake may help boost the immune system, according to research. There is evidence to connect oil intake, WBC malfunction, and intestinal microbial population imbalance (Chaari et al., 2020). Several reliable research connects nutrition and immunity. For example, immune cells need energy to efficiently fight pathogens. As a result of immune activation, the body consumes more energy during illness. The building blocks of immune proteins including immunoglobulins and cytokines, amino acids are necessary. To maintain their antioxidant defensive system against infection, immune cells need iron, zinc, magnesium, and vitamins C and E (Monye & Adelowo, 2020b). Anti-inflammatory and antioxidant micronutrients like vitamin E may assist the immune system combat infections by interacting with enzymes and transport proteins. These vitamins are especially important during viral infections when oxidative stress increases. Immune cell gene expression is increased by micronutrients (Farhadi & Ovchinnikov, 2018).

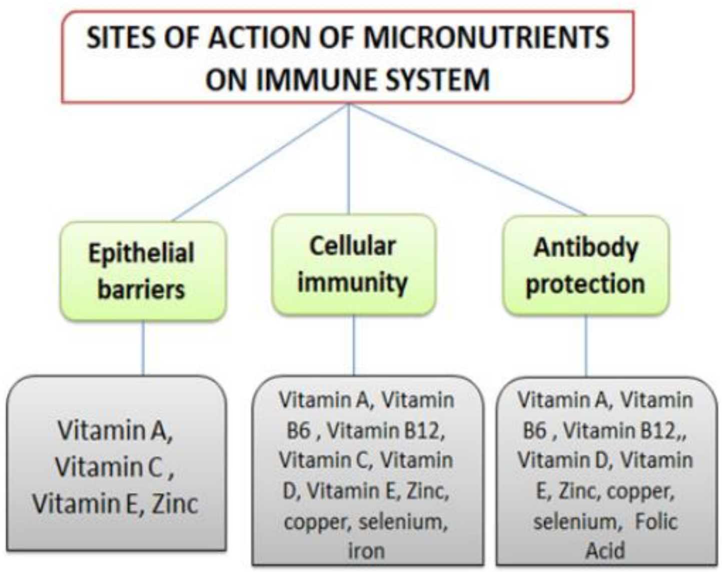

Figure 2: Micronutrient action sites on immune system (Karacabey, 2012).

Lack of nutrients can cause malnutrition, which affects the immune system and can cause disorders. The immune system's incapacity to adapt to some nutrients and other cells has also been found to produce persistent, low-grade systemic inflammation (such as adipocytes). Patients with weakened immune systems are more susceptible to infections like COVID-19 (Childs et al., 2019). It should be simple to promote rapid anti-infection responses while avoiding persistent inflammation. Plant-based and Mediterranean diets are suggested for this diet. To keep this diet, eat a variety of fresh fruits and vegetables, whole grain products, nuts, seeds, and seafood. Anti-inflammatory diets and meals rich in minerals and antioxidants can help decrease inflammation. (Monye & Adelowo, 2020b). The immune system guards against germs, viruses, and malignant cells. Weak immune systems, bad nutrition, and more diseases result from poor diet. A nutritious diet may help prevent or stop the aging immune system's decline. Some meals may help boost immunity and prevent colds and flu. The immune system must keep viruses and germs at bay to keep the body healthy. Malnutrition increases infection risk and severity (Namdeo, 2021).

Good nutrition promotes immunity. Vegetables may help. Strawberry anti-inflammatory antioxidants Contain minerals and selenium. Selenium-rich oats Oncolytic oxytetracycline Meat and fish iron Some are immune-stimulants. Like entire wheat. Beans, spinach, and greens B6 is found in bacon and tuna. Citrus and leafy greens. These foods contain it. sprouts Vitamin A food sources (Alpert, 2017). Eating less and exercising more may boost the body's immune system. Obesity has been related to an increased risk of sickness. A plant-based diet has several health benefits, including better digestion and lower calorie consumption. A healthy BMI has been linked to better immune function. A diet rich in fruits, vegetables, and whole grains also decreases inflammatory indicators (Rinninella et al., 2019).

Now, we will discuss the important role of different kinds of nutrition, micronutrition, vitamins & several trace elements in our immune system.

Carbohydrate: Carbohydrates provide a lot of energy to the immune Increased anaerobic glycolysis increases glucose consumption in lymphocytes in response to mitogens. During lymphocyte proliferation, carbohydrate intake decreases. Nucleotides such as purines and pyrimidines are made from glycolytic mid products to stimulate cell growth (Kumar & Nutrition, 1997). All plant foods contain carbon, hydrogen, and oxygen atoms. Sugary and intricate are two popular categories (starch). Glue ides are in sugar, fruits, and juice. But complex starch is found in many foods. Glycogen, a kind of liver carbohydrate storage is small. Other organs and muscles contain glycogen. Blood glucose is essential for tissues as a source of constant energy. As previously stated, a high-CHO diet excluding raw CHO sources negatively impacts the immune system. CHO is essential for the immune system's capacity to fight cell death as well as maintain healthy cell counts (Karacabey, 2012).

Magnesium: A magnesium deficiency might lead to immune system cell death. A reduction in serum antibody concentration associated with the production of resistance protein components may suggest Mg deficiency or poor status. Properdin's involvement is also required. Mg2+ is a cofactor in DNA, RNA, ATP, and enzymes. TCRs on T-cell surfaces recognize and respond to foreign antigens (Son et al., 2007). Due to the body's defense system being impaired, T-cells cannot elevate intracellular levels of free Mg2+ in response to TCR activation. This means that appropriate dietary Mg can meet the daily need (François et al., 2020). The presence of magnesium in our bodies stimulates the activity of natural killer lymphocytes and cells. Our cells cannot function correctly without adenosine triphosphate (ATP) as an energy source. Magnesium may treat respiratory disorders like COVID-19 by assisting hemoglobin, which carries oxygen from the lungs to all of our cells (Namdeo, 2021).

Iron: The immune system must function appropriately. Iron is a coenzyme essential for many biological processes. The reticuloendothelial system's macrophages recycle most of the iron that enters the circulation. I Proliferation and maturation of iron-rich cells are stimulated by immune cells, particularly lymphocytes. The body has created proteins like transferrin and lactoferrin that bind to iron and prevent infections from consuming it (Alpert, 2017). Iron deficiency in the thymus can influence natural killer cell activity, T-lymphocyte proliferation, and respiratory function, as well as change the immune system. Iron-rich meals are crucial for reducing COVID-19 infection because they help increase immunity. T-lymphocyte proliferation was found to be 50%-60% lower in older Canadian women. Malaria and other illnesses, including pneumonia, increase in risk when iron levels rise. As a result, giving excessive doses of iron to youngsters in malaria-prone areas is not advised (François et al., 2020). Low iron diets can induce anemia and a weakened immune system. Iron-rich foods should be eaten alongside vitamin C to maximize their nutritional value. Iron supplementation can help maintain a healthy iron level in the blood, but too much of a good thing can be dangerous. If you lack iron, you should only take iron supplements.

Copper: Copper is necessary for immune system functions. Copper enzymes govern energy production, iron metabolism, connective tissue formation, and neurotransmission. Copper is an essential cofactor in oxidation-reduction processes (Percival, 1998). Copper also promotes bone health, balance, and immune system function. Many degenerative illnesses have been revealed to be associated to its lack. To combat invading microorganisms by initiating the respiratory burst requires a copper blood condition. In humans, a low copper diet reduced lymphocyte proliferation and interleukin-2 (IL-2) production, which were both restored by copper supplementation (Bonham et al., 2002). Cupric copper (Cu2+) is the most abundant copper in the body and is used in redox activities and as a free radical scavenger. Interleukin-2 production and T cell proliferation are decreased in individuals with mild to severe insufficiency. I Neutrophils decrease in number, capacity to produce superoxide anion, and destroy microbes in severe deficiency. It also minimizes the amount of neutrophils in peripheral blood circulation (Percival, 1998).

Selenium: Selenium affects the innate and acquired immune systems, according to research. It is necessary for both redox control and antioxidant activity. WHO claims it's the most important nutrient for those with HIV/AIDS and other chronic illnesses. This supplement can help protect against the cytomegalovirus, which can harm the heart. Its protective effects on oxidative stress are due to a synergistic impact between selenium and the antioxidant glutathione (Alpert, 2017). The cytosolic glutathione peroxidase membrane has a selenium reaction. Serum T-cell proliferation and T-helper cells are boosted by selenium. Reduced NKT cell activity and increased mycobacterial infections in selenium deficient humans Animals with low selenium levels had lower T and B cell activity, antibody production, and infection susceptibility. This includes coxsackievirus, poliovirus, and H1N1. Humans needed 100-300 g selenium daily. Toxsackievirus B3 endemic cardiomyopathy was reduced when selenium deficiency was treated. Selenium and selenoproteins are engaged in different cellular and viral activities. Infections with RNA viruses cause oxidation. Regional or city hair cure rates recently studied In China, COVID-19 cure rates were associated to selenium. Increasing daily selenium consumption makes logical now since selenium affects RNA viruses like SARS-CoV-2 (François et al., 2020).

Zinc: Zinc is a mineral included in many supplements and other health care products, such as lozenges, that assist maintain or boost immune system function. Zinc is necessary for immune cell proliferation and communication, as well as antibody synthesis and inflammation control (Namdeo, 2021). Many studies have shown that zinc is crucial for the growth of cells, especially immune cells. Zinc affects the immune system, particularly the innate and adaptive immune systems. Several investigations have shown that unbound zinc ions have antiviral properties. Zinc supplementation increases the quantity of cytotoxic CD8+T cells and antibody reaction (Alpert, 2017). Zinc is an essential trace element in numerous biological processes. Zinc deficiency has been linked to decreased naive B-lymphocyte production in the thymus bone marrow and immunological progenitor cells. Intrinsic phagocytosis and NK cell function Zinc aids in the release of neutrophil extracellular traps. Cofactor for Phospholipase A2 may activate NADPH oxidase (Farhadi & Ovchinnikov, 2018)(Teixeira et al., 2014). If zinc is present, arachidonic acid can be stabilized for iron complex oxidation. Zinc deficiency inhibits iron absorption. copper uptake Zinc reduces lymphocyte phagocytosis. Iron supplementation may cause zinc insufficiency. Daily zinc (20 mg) and selenium (100 mg) reduced infection risk. RNA viruses like coronaviruses require zinc blocks. RNA polymerases replication hosts RNA virus defenses that may benefit from zinc. Zinc decreased flu virus pyrrolidine dithiocarbonate in vitro. Zinc can reduce SARSCoV-2 by copying it. Humans with mild zinc deficiency have reduced T-lymphocyte proliferation, IL-2 production, and cellular immunological responses. Zinc supplements may help. Hypozincemia causes pneumonia and diarrhea (François et al., 2020).

Fatty acid: This nutrient, commonly known as vitamin F, is required to satisfy the body's daily Omega-3 fatty acid requirements. A lack of EFAs may impair the body's capacity to create antibodies, which are vital for defense. Linoleic acid, an n-6 lipid, is required for normal immune cell formation and proliferation. Prostaglandin (PG) production uses prostaglandin and leukotriene as substrates. During pandemic epidemics, mediated immune response cells require fatty acids. Polyunsaturated fatty acids (n-6 PUFA) such as linoleic and arachidonic acid increase PGE2 production in macrophages (Gutiérrez et al., 2019). Anti-inflammatory properties of omega-3 fatty acids. Omega-3s may help macrophages become less polarized. However, alfa linoleic acid (ALA), Docospentahexaenoic acid (DHA), and Eicosapentaenoic acid (EPA) may assist macrophages in better absorbing foreign molecules. The capacity of omega-3 fatty acids to boost phagocytic ability has been demonstrated for zymosan fragments, and this impact may be linked to changes in the content and structure of the cell membrane. DHA also stimulated NK cells in the spleens of mice (François et al., 2020).

Probiotics: Probiotics are beneficial bacteria that assist the host. They improve gut immunity by decreasing germs, avoiding infection, and removing toxins. Studies show that these bacteria's immunomodulatory properties boost NK activity and numbers. The reduction in lymphoid cell activity makes the elderly more susceptible to infectious and non-infectious diseases. The gut microbiota is strongly influenced by the nutrients people take on a daily basis to promote natural killer cell activity and hence the immune system (Hardy et al., 2013). Additionally, Age as well as illness status have a big influence on the microbiota. While bifidobacteria decrease in diversity and abundance with age, streptococci, enterococci, staphylococci, and enterobacteria grow in quantity. This is an interesting discovery in select Chinese COVID-19 patients with low lactobacilli and bifidobacteria levels (Calder et al., 2020). Despite this, probiotics may have therapeutic effects in COVID-19 patients. Probiotics can create antibacterial chemicals in addition to bacteriocins and other acids. Probiotic-rich foods, such yogurt or curd, are beneficial for the elderly, especially those with weakened digestive systems (François et al., 2020).

Quercetin: In addition to its anti-cancer and anti-inflammatory characteristics, quercetin has been shown to reduce lipid peroxidation (the body's production of free radicals), platelet aggregation, and capillary porosity. The antioxidant quercetin protects mice against aggravation by increasing cytokine release (Li et al., 2016). For example, quercetin has been proven to help the immune system combat herpes simplex viruses, parainfluenza virus , adenoviruses as well as SARS (Davis et al., 2009). It is yet unknown how this impact works. Quercetin may reduce viral replication in the respiratory system, according to some research. Cell division is prevented by molecular anchoring. DNA virulence enzymes, for example, have been lowered. Gyrase interacts with lipase and viral particles. These are capsid proteins. Then comes money. During this time span, Quercetin intake increased in diet. The epidemic stage may help humans (François et al., 2020).

Proteins: Proteins are made up of four elements: nitrogen, carbon, hydrogen, as well as oxygen. The immune system produces active protein molecules and/or cell units. The immune system function is hampered by protein insufficiency. The immune system regulator's impact on particular amino acids is linked to protein shortage and decreased immunity. A lack of key amino acids may also delay the immune system. Too many amino acids may weaken the body's capacity to fight illness. A recent study shows that protein metabolism is vital for both natural and acquired immunity to viruses (Karacabey, 2012).

- **Arginine:** Arginine is an amino acid commonly utilized in hospitalized patients' therapy. Due to its high nitrogen content, it is a conditionally necessary amino acid and cannot be synthesized by endogenous syntheses. Lymphocytic progression, phagocytosis, and wound healing have all been demonstrated to improve (Evoy et al., 1998). It improved alveolar macrophage phagocytosis. Microbicidal chemicals appear to be involved in macrophage killer activity and the modulation of macrophage interactions (Medicine, 1999). It improves T-cell response after major surgery or trauma. This is due to arginine insufficiency. It is also anti-cancer. It enhances nitrogen balance and anabolic hormone production. Need further research on arginine's immunological nutrition role (Karacabey, 2012). To work properly, polyamine synthesis relies on arginine levels. More arginine-rich diets or arginine supplements may assist patients with COVID-19 create more blood lymphocytes, T cells, and alveolar macrophages (François et al., 2020).
- **Glutamine:** It is also a crucial ingredient for quickly multiplying cells. It includes antioxidants, glutathione pyrimidine nucleotides, and gamma-aminobutyric acid synthesis. It may help cure cancer and intestinal damage. This approach may prevent intestinal blood against microbial infection (Karacabey, 2012). Glutamine appears to be involved in several

biological functions. For ammonia excretion and acid load neutralization in the kidneys, and intestinal enterocyte, macrophage, lymphocyte and colonocyte proliferation (Medicine, 1999). It modulates acid-base balance. It produces glutathione. Inject it orally. Oral therapy lowers mortality in low-birth-weight babies. This protein transfers nitrogen across organs. Glutamic acid may increase CD4+ and CD8+ lymphocytes in bone marrow transplant patients (Evoy et al., 1998). Increasing glutamine intake may also help COVID-19 patients recover, as glutamine reduces infection rates (François et al., 2020).

Nutrient	**Good dietary sources**
Magnesium	Green vegetables as example kale as well as collard green; legumes; nuts; seeds, whole grain.
Iron	Meat, fortified cereals, beans, liver, nuts, dried fruits, whole grains, green leafy (kale, spinach, cassava leaf)
Selenium	Fish, shellfish, tofu, whole-grain cereal, meat, eggs, milk, sunflower seeds, some nuts.
Copper	A wide variety of seafood like Shellfish, oysters, and nuts, as well as organ meats, liver, some vegetable wheat-bran cereals, whole grain foods.
Quercetin	Garlic, onion, oily fish, broccoli sprouts, cranberry juices.
Fatty acids	Nuts, seeds, fish and vegetable oils.
Probiotics	Yogurt, curd
Zinc	Shellfish, meat, seeded or wholegrain bread, some grains and seeds, cheese, cereals.

Vitamin A	Milk, carrots, sweet potatoes, cheese, pumpkin, eggs, spinach, fortified cereals, liver, broccoli, oily fish, green vegetables and fruits like peaches, papaya, tomato, mango, cantaloupe, orange, melon.
Vitamin B12	Fish, fortified cereals, meat, yeast extract, eggs, some shellfish, milk and cheese.
Vitamin B6	Whole grain cereals, poultry, fortified cereals, fish, fruits, meat, soya beans, fish, tofu, eggs, yeast extract, green vegetables.
Vitamin C	Fruits and vegetables include orange juice, blackcurrants, kiwi and broccoli, red and green pepper, strawberries, potatoes, citrus fruits, and guava.
Vitamin D	The main source is sunlight, liver, cereals, mushrooms, eggs, fortified food spreads, and oily fish (salmon, sardines
Vitamin E	Vegetable oils, peanuts, nuts, wheat grain, seeds, eggs, tuna, salmon, sunflower oil.
Folate	peas, chickpeas, fortified cereals, widely spread in green leafy vegetables (spinach, cabbage, kale, broccoli).
Amino acids	Meat, soya, nut, poultry, milk, cheese, fish, eggs, seeds, pulses

Table 1:Immune-boosting substances may be found in a variety of foods (Calder et al., 2020; Jayawardena et al., 2020)

Vitamins: Vitamins are essential components of the body. We eat them, Minerals and vitamins are micronutrients since their needs are small compared to those of carbohydrates, proteins, and fats (Darbar & Saha, 2020). Vitamins are nutritional components that are essential for growth, development, neurologic and digestive functions, food utilization, immune system support, and sanitary protection. These enzymes are important regulators of cellular metabolism and metabolism. Nutrient deficiency limits the body's capacity to grow and function. A, D, E, and K are fat-soluble, whereas B and C are water-soluble. These vitamins' immune-boosting properties have been thoroughly researched (Karacabey, 2012). Vitamin deficiency can cause a host of problems. Immune system dysfunction is caused by vitamin deficiency. Anthocyanins (Vitamin A), pantothenic acid (Pantothenic Acid), pyridoxine (Karacabey et al., 2005). Taking a multivitamin with vitamins A, E, C, carotene, and folic acid may help relieve heart and vascular problems. Furthermore, future research shows that carotene supplements have minimal benefits. Vitamin C is effective in the treatment of atherosclerosis. Cancer patients who take vitamin C enjoy a greater quality of life and live longer (Harbige, 1996).

Vitamin A: Its action in the immune system makes it an "anti-inflammatory vitamin." Among its key functions are improving the immune system and administering cellular immune responses and oral immunological activities. Vitamin A affects mucosal nucleus cell integrity and immunity (Mishra & Patel, 2020). Vitamin A, like vitamins D, E, and K, is a fat-soluble vitamin. This protein affects epithelial tissue growth, maturation, and physiological activity. In other words, a lack of vitamin A decreases immunity, making people more prone to disease, and weakens the body's natural defenses (Medicine, 1999). Vitamin A increases T and B lymphocyte proliferation, cytokine activity, and the ability of macrophages, cytotoxic T cells, and natural killer cells to destroy tumors. It also protects phagocytic cells from auto-oxidative damage via its antioxidant capabilities (François et al., 2020). Vitamin A shortage makes the eyes, lungs, and digestive systems susceptible to infection. Malnourished youngsters receive vitamin A, which protects them against measles. When given to cortisone-treated mice, vitamin A appears to prevent the immunosuppressive effects. Vitamin A supplementation increases antibody titer levels in patients. White blood cell activity is increased, as is the first line of defense against infection, the skin as well as mucous membranes (Alpert, 2017). The human immune system suffers from a deficiency of vitamin A. Vitamin A and its metabolites affect neutrophil maturation, altering immunological and barrier function. Vitamin A deficiency increases neutrophil counts but lowers phagocytic function. Vitamin A supplementation reduces mortality and morbidity in several infectious diseases, including measles, diarrhea, measles with pneumonia, malaria, and HIV/AIDS (Calder et al., 2020). β-carotene reduces inflammation and boosts the body's immunity. Age-related changes in body composition (Mishra & Patel, 2020).

Vitamin A's Natural Source	Causes of Vitamin A Deficiency	Amount of Vitamin A Man and Woman should consume each day	
• Sweet potato • Spinach • Egg • Cheese • Broccoli • Peppers • Apricots • Carrots • Pistachio nuts	• Anemia • Night Blindness • Measles • Diarrhea	Male	Female
		Age 1-3 years- 300 mcg	Age 1-3 years- 300 mcg
		Age 9-13 years - 600 mcg	Age 9-13 years -600 mcg
		For adults – 900 mcg	For adults- 700 mcg For pregnant -770mcg For lactating-1300mcg

Table 2: Recommendations for a healthy diet for Vitamin A (Farhan Aslam et al., 2017).

Vitamin B6 (pyridoxine): The immune system benefited from riboflavin, B6, B12, and folic acid. The immune system's most critical B vitamin is B6 (Karacabey, 2012). Immune system function is affected by vitamin B6 deficiency. Decreased production of Th1 cytokines leads to increased production of Th2 (Calder et al., 2020). In studies, B6 at 50 mg/day improved immune function in critically sick individuals. Vitamin B6 deficiency impairs IL-2 production and responses to T- and B-cell mitogens (Cheng et al., 2006). Vitamin B6, B12, and folic acid, among others, have been proven to promote the activity of natural killer cells and CD8+ T-lymphocytes (François et al., 2020). Vitamin B6 is necessary to maintain homocysteine levels. Elevated homocysteine raises the risk of cardiovascular disease. Vitamin B6 is composed of pyridoxine, pyridoxal, and pyridoxamine. With B6, PLP is a feasible option for all three kinds. Vitamin B6's coenzyme form is engaged in reactions, and it's reasonable to state that B6 is required for most key biological responses such as humoral and cellular immune responses (Mishra & Patel, 2020). Vitamin B6 is required for both red blood cell and immune system cell production and absorption. One of the most important neurotransmitters is serotonin. Tryptophan and pyridoxal phosphate, a vitamin B6 derivative, is required for the production of serotonin. Norepinephrine and melatonin, which affect mood and body clock, help brain growth and function. Anxiety, muscle weakness, and memory loss were all severe deficiencies (Farhan Aslam et al., 2017).

Sources of Pyridoxine (B6)	Causes of B6 Deficiency	Amount of Vitamin B6 Man and Woman should consume each day	
• Beef liver • Chickpeas • Cereals • Onions • Tuna • Salmon	• Depression • Weak immunity • Anemia • Dermatitis • Confusion	Male	Female
		Age 1-3 years- 0.5 mg	Age 1-3 years- 0.5 mg
		Age 9-13 years -1 mg	Age 9-13 years -1 mg
		Adults – 1.3 mg	1.3 mg (adults) 1.9 mg (pregnant) 2.9 mg (lactating)

Table 3: Recommendations for a healthy diet for Vitamin B_6 (Farhan Aslam et al., 2017).

Vitamin B9 (Folic acid): As a key enzyme in the production of nucleic acids, proteins, and DNA Taking folate or vitamin B9 can significantly boost immunity. Vitamin B9 deficiency may impair infection resistance. It usually serves tissue (Stover, 2004). Water-soluble folic acid is a source of nucleic bases and purines, as well as a precursor to coenzyme tetrahydrofolate. In an animal model, the thymus and spleen decreased, and T-lymphocyte numbers fell. Increasing dietary folate intake can also help repair neutrophil dysfunction (Calder et al., 2020). Soluble vitamins for cell division and the formation of new cells in the bone marrow and other organs that create blood cells, foliate is produced as folic acid. Its principal purpose is energy generation. Folic acid is transformed into tetrahydrofolic acid, which is required for the formation of DNA and proteins. The lack of macrocytic anemia enables red blood cells to develop. Red and white blood cell sizes and compositions are aberrant in macrocytic anemia (folic acid deficiency). Folic acid is essential for brain function and mental and emotional health. Lack of central nerve tissue can cause depression, insomnia, fatigue, and anxiety (Alpert, 2017). Additionally, Folic acid also enhances or maintains NK cell cytotoxic function, which may help the body fight this infection (François et al., 2020).

Natural Sources	**Causes of B9 Deficiency**	**Amount of Vitamin B9 Man and Woman should consume each day**	
		Male	Female
• Lettuce • Beans • Avocado • Rice • Spinach • Salmon • Peanuts • Shellfish • Egg	• High homocysteine levels • Tongue ulcers • Fingernail pigmentation • Megaloblastic anemia	Age 1-3 years- 150 mcg	Age 1-3 years- 150 mcg
		Age 9-13 years - 300 mcg	Age 9-13 years -300 mcg
		Adults – 400 mcg	400 mcg (adults) 600 mcg (pregnant) 500 mcg (lactating)

Table 4: Recommendations for a healthy diet for B9 (Farhan Aslam et al., 2017).

Vitamin B8 (Biotin): Biotin uses electrostatically bound lysine residues to regulate gene expression and chromatin structure (Crisp et al., 2004). Biotin deficiency may affect cellular and humoral immune systems. A lack of biotin reduces antibody production, spleen cell count, B-lymphocyte percentage, and impairs thymocyte growth (François et al., 2020). Foods rich in biotin, such as liver, egg, kidney beans, milk, swiss chard, Almonds, tomato, lettuce, onions, cabbage, oats, cauliflower, strawberry, and nuts.

Vitamin K: Vitamin K required for coagulation and protein modification has been related to immune cells. Vitamin K's role has been connected to immunological cells. Protein S, a vitamin K-dependent protein, is likely connected to C4B binding protein (C4BP), indicating that B cells benefit from the vitamin. Kale, Spring Onions, Avocado, Blackberries, Blueberries, Cabbage, Spinach Prunes, Broccoli & Kiwi are rich sources of Vitamin-K (Karacabey, 2012).

Vitamin B12 (cobalamin): Vitamin B12 is also called "cobalamins" due to its cobalt content. Because it is water-soluble, frequent consumption is required. For example, cobalamin deficiency affects pathogen infection and illness progression. Vitamin B12 stimulates B cell immunoglobin production in response to the pokeweed mitogen, while simultaneously stimulating T cell proliferation (Rowley & Kendall, 2019). Vitamin B12 participates in cell division and proliferation, two activities crucial to immune function. Without B12, white blood cells cannot develop and multiply. Immunocompetent elderly people with low blood vitamin B12 levels exhibited a reduced immunological response to pneumococcal polysaccharide vaccine (Alpert, 2017). Anemia patients' immune responses to viruses and bacteria are reduced. However, neutropenia and other white blood cell abnormalities are frequent in children due to low vitamin B12 levels (Maggini et al., 2007).

Natural Sources	**Causes of B12 Deficiency**	**Amount of Vitamin B12 Man and Woman should consume each day**	
• Egg • Milk • Cereals • Yogurt • Trout • Cheese	• Confusion • Weight loss • Weakness • Fatigue • Megaloblastic anemia • Depression	Male	Female
		Age 1-3 years- 0.9 mcg	Age 1-3 years- 0.9 mcg
		Age 9-13 years - 1.8 mcg	Age 9-13 years -1.8 mcg
		Adults – 2.4 mcg	2.4 mcg (adults) 2.6 mcg (pregnant) 2.8 mcg (lactating)

Table 5: Recommendations for a healthy diet for for Vitamin B_{12} (Farhan Aslam et al., 2017).

Proteins and nucleic acids can't be produced correctly without vitamin B12. Insufficient nucleic acid and protein synthesis reduced immune cell function and delayed metabolic processes. This nutrient's availability affects red blood cell creation, nervous system function, and DNA synthesis. It helps make B and T lymphocytes. Vitamin B12 can help manage homocysteine levels in the blood. Vitamin B12 is an immunomodulator for cells (Mishra & Patel, 2020). Humans and plants cannot naturally produce vitamin B12. Only microbes have the enzymes needed to make B12.

Vitamin C: Vitamin C has been related to reduced cancer risk and wound healing. To avoid infection and irritability. According to a Cochrane review, taking Vitamin C supplements significantly reduced the occurrence of respiratory infections. This vital vitamin is required for the body's defense system. It prevents the common flu. Iv vitamin C seems to help sepsis as well as ARDS patients (Mishra & Patel, 2020). Vitamin C (L-ascorbic acid) is found in nearly every biological tissue, although its concentrations are highest in the pituitary and central nervous system. Vitamin C improves intestinal iron absorption and regulates iron transit for storage (Farhan Aslam et al., 2017). To produce dopamine and noradrenalin, as well as catecholamines, Vitamin C helps the brain produce them naturally (Huskisson et al., 2007). Doctors recommend this water-soluble vitamin to treat pneumonia. A healthy epithelium and collagen production require vitamin C. Protects against oxidative stress in the adaptive and innate immune systems. Nutritional deficiencies reduce neutrophil and macrophage bactericidal action, making the body more susceptible to infections. In addition to modulating prostaglandin (PG) synthesis, protecting against 5'-lipoxygenase and enhancing cytokine production, modifying intracellular CYP2D6 levels, and antagonizing histamine-leukocyte interactions, vitamin C also neutralizes phagocyte-derived autoreactive and immunosuppressive oxidants (Carr & Maggini, 2017). Healthy young people who were low in vitamin C had half the vitamin C content of their mononuclear cells and T lymphocyte-mediated immunological recall responses to antigens. Preventing and treating upper respiratory infections (Calder et al., 2020). When an infection is over, vitamin C levels in leukocytes return to normal. Thereby demonstrating that vitamin C is vital in avoiding infection spread (Hume & Weyers, 1973). Vitamin C boosts neutrophil and monocyte mobilization. During an illness, white blood cells quickly deplete the body's vitamin C store. Immunoglobulins and cytokines are produced by T cells in response to infection (Alpert, 2017). In a typical infection, activated phagocytes produce reactive oxygen species (ROS), which oxidize host cells. Vitamin C may help reduce some of these undesirable effects. Vitamin C is a powerful reducer because it can give up its own electrons to receiver molecules. In redox, vitamin C is an antioxidant as well as an enzyme cofactor. Free radicals and reactive oxygen species (ROS) can't affect proteins, lipids, carbohydrates, or nucleic acids (DNA and RNA) since vitamin C is a nonenzymatic antioxidant. Vitamin C can be used to repair oxidized vitamin E (Carr & Maggini, 2017).

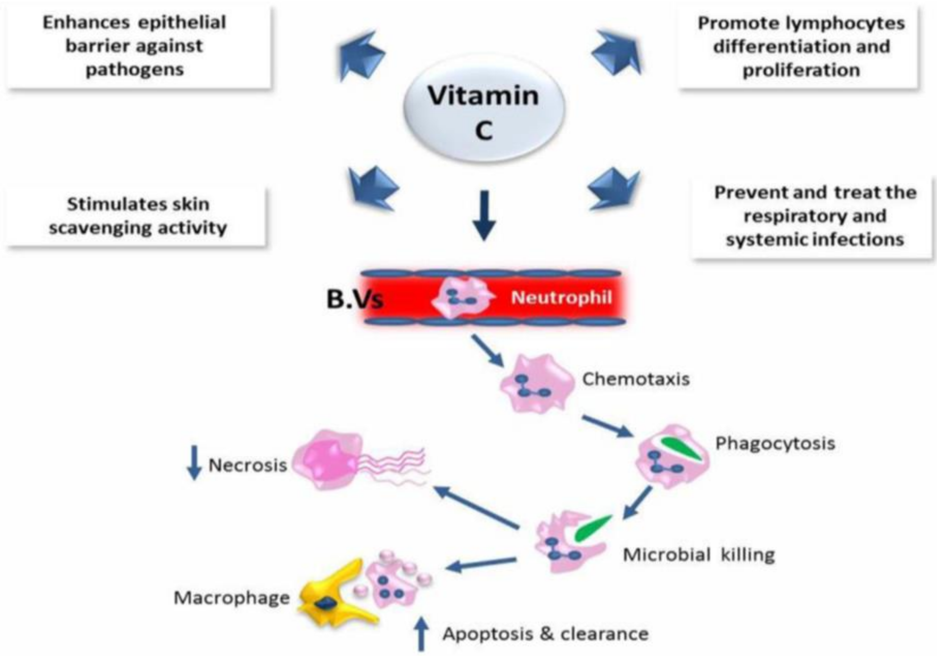

Figure 3: Function of vitamin C in body defense (Carr & Maggini, 2017).

A shortage in vitamin C results in a decreased ability of electron transporters like cytochrome P-450 to metabolize drugs(Farhan Aslam et al., 2017). Vitamin C may help the body's immune system fight new coronaviruses. Vitamin C has a function in the cytokine storm caused by COVID-19 infection. Proinflammatory cytokines like IL-1 and TNF- are produced early in infection. This promotes chronic inflammation. TNF helps SARS-CoV-2 enter host cells. The supplement reduces IL-1 and TNF, two inflammatory cytokines (IL-10). When taking vitamin C daily, peripheral blood mononuclear cells create IL-10. In COVID-19, IL-10 controls inflammation via negative feedback. Immune senescence and impaired immune cell activity make older persons more prone to infection. Vitamin C intravenous enhances inflammatory biomarkers and respiratory measures (Shakoor et al., 2021). Consumption of vitamin C-rich fruits and vegetables will assist enhance the body's defenses during this pandemic (François et al., 2020). Most animals' livers manufacture vitamin C, allowing them to restock. Enzyme insufficiency prevents the body from producing vitamin C. Vitamin C-rich meals are therefore essential for maintaining good health. Taking vitamin C supplements raises levels in 2–3 grams of tissue, with the rest eliminated in urine (Alpert, 2017).

<table>
<tr><th rowspan="2">Natural Sources</th><th rowspan="2">Causes of C Deficiency</th><th colspan="2">Amount of Vitamin C Man and Woman should consume each day</th></tr>
<tr><td>Male</td><td>Female</td></tr>
<tr><td rowspan="3">• Tomato
• Cantaloupes
• Cabbage
• Lemon
• spinach
• Oranges
• Green pepper
• Guava</td><td rowspan="3">• Weak immunity
• Scurvy</td><td>Age 1-3 years- 15 mg</td><td>Age 1-3 years- 15 mg</td></tr>
<tr><td>Age 9-13 years -45 mg</td><td>Age 9-13 years -45 mg</td></tr>
<tr><td>Adults – 90 mg</td><td>75 mg (adults)
85 mg (pregnant)
120 mg (lactating)</td></tr>
</table>

Table 6: Recommendations for a healthy diet for Vitamin C (Farhan Aslam et al., 2017).

Vitamin D: Fat-soluble vitamin D is required for calcium metabolism and bone homeostasis. Vitamin D also has a role in innate as well as adaptive immune responses (Mullins & Camargo, 2011). Vitamin D is essential in maintaining healthy blood calcium and phosphorus levels. Vitamin D is acquired through fish or fish oil, or synthesized endogenously (Karacabey, 2012). D2 and D3 are subclasses of vitamin D2. Vitamin D is commonly referred to either ergocalciferol (D2) or cholecalciferol (D3) In bones and teeth, they help preserve bones and teeth. Sunlight, fish liver oils, as well as eggs, are the main sources of vitamin D. Rheumatoid arthritis (RA) is a chronic inflammatory illness that affects the joints and bones. Humans require both vitamin D3 and vitamin D2, however, only vitamin D3 is produced in human cells by UV radiation from the sun, while vitamin D2 is produced in plants and may be obtained from plants (Farhan Aslam et al., 2017). Treatment with vitamin D increases the ability of immune cells to phagocytose and kill pathogens. This stimulation also helps monocytes as well as dendritic cells develop and digest antigens. Vitamin D contributes in reducing adipose tissue inflammation and increasing antimicrobial peptide production in epithelial as well as macrophage cells (Gombart, 2011). Since its discovery as a cell receptor, vitamin D has many other activities. Activated vitamin D metabolite can be generated by B, T, and antigen-presenting cells. The thymus has the most vitamin D receptors, especially immature immune cells and mature CD8+T cells. Infections and autoimmune illnesses are linked to low vitamin D levels. It acts as an immunosuppressant in animals, decreasing the risk of autoimmune diseases and preventing them in some cases, according to Deluca & Cantorna (Deluca & Cantorna, 2001). Vitamin D insufficiency weakens the immune system, placing you at risk of viral infections. Vitamin D insufficiency may have increased the risk of lung injury, ARDS, diabetes as well as other cardiovascular concerns in COVID-19 pandemic patients. Vitamin D also affects the renin-angiotensin system, protecting against cardiovascular disease (RAS). Vitamin D shortage may boost the ability to fight COVID-19 and lower its severity. Vitamin D supplementation may raise TLR and cathelicidin/b-defensin levels in COVID-19 patients. Plasma cell-secreted immune system-altering cytokines can damage T cell tolerance. It should be between 40–60 ng/ml (100–150 nmol/L) (Alagawany et al., 2021). The body converts 7-dehydrocholesterol (7-DHC) from the epidermis into the fat-soluble hormone precursor cholecalciferol. The hydroxylation process has two steps: The liver creates 25HVD, which is then converted to 1,25(OH)2D in the kidneys. Vitamin D boosts antimicrobial peptide production like cathelicidin and defensin. Adhesion molecules and anti-oxidative gene expression in cells are controlled by defensins. Viruses like influenza are known to disrupt epithelial tight connections, increasing infection risk and pulmonary edema. Vitamin D receptor expression is known to maintain the integrity of these junctions (Darbar & Saha, 2020). Enzymes like CYP27A1 and CYP2R1 in mitochondria and microsomes help convert vitamin D to vitamin D2 (25-hydroxyvitamin). In the kidneys, CYP2R1 converts vitamin D2 to vitamin D3 (1,25-dihydroxyvitamin). A number of immune responses are triggered by D3-binding proteins such as macrophage and dendritic cell VDRs (Sadarangani et al., 2015). It also improves the modulation of lipopolysaccharide surface receptors on T cells (Zhang et al., 2012). Vitamin D3 may help reduce insulin resistance (ergocalciferol). Vitamin D3 activation introduces monocytes to Mycobacterium tuberculosis (Hewison, 2012). Supplementation with vitamin D may also help to regulate inflammation, which may play a role in chronic illness(Farhan Aslam et al., 2017).

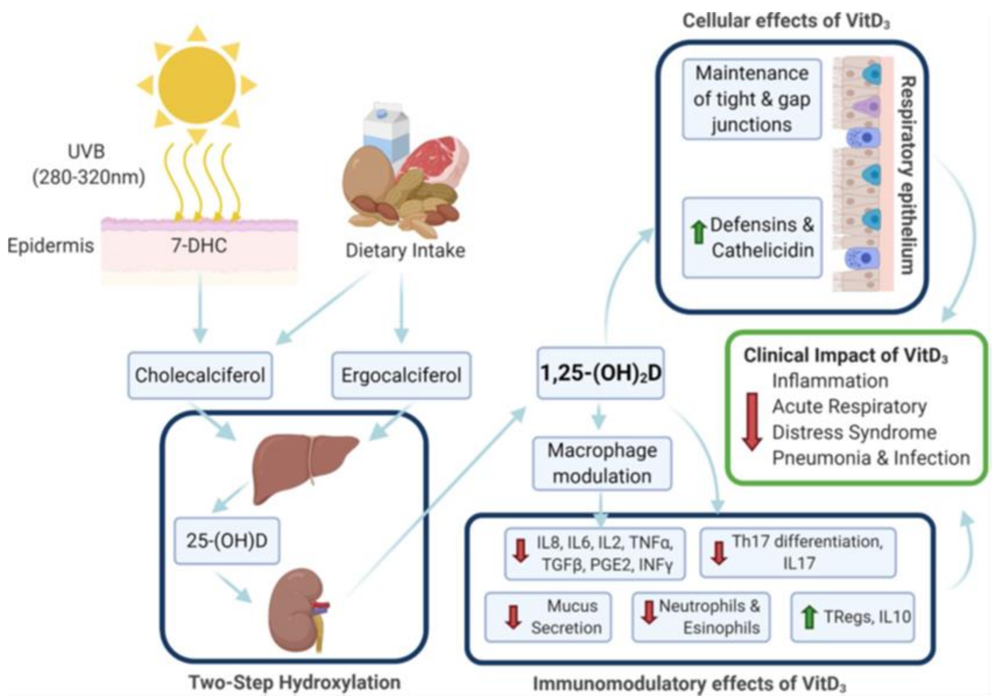

Figure 4: Immunomodulatory actions of vitamin D (Shakoor et al., 2021).

Inflammation is a major cause of chronic disorders like diabetes and must be treated. Obesity and diabetes, the most common being type II diabetes, are both caused by inflammation (Pickup, 2004). "Inflamm-aging" is the progression of chronic illness in older people due to chronic low-grade inflammation. -cytokines. It has been shown that vitamin D supplementation increases anti-inflammatory cytokines and pro-ARDS in elderly people during a cytokine storm (Razdan et al., 2020). In the winter, when the Covid-19 outbreak is at its height, northerners are more likely than southerners to be vitamin D deficient (January-May). In the winter, the days are shorter. In nations with high levels of vitamin D, insufficient vitamin D has been related to increased COVID-19 morbidity and death, a condition common in Spain and Italy, that has been linked to COVID-19 infections. People living in the Nordic nations (Iceland, Finland, Greenland, as well as Norway) have a higher fatality rate due to vitamin D deficiency (Braiman, 2020). Several viral illnesses, including influenza, have been linked to a lack of vitamin D in the human body(Goncalves-Mendes et al., 2019). Vitamin D-induced anti-inflammatory cytokine release by Th2 cells and inhibition of Th1 cells reduce the amount of pro-inflammatory regulatory T cells (Shakoor et al., 2021). Vitamin D may have immunomodulatory effects, according to research. A daily intake of 15 mcg is recommended for optimal immune function, reduced autoimmune disease incidence, and improved clinical image. It is also an immune system modulator (Cantorna et al., 2012).

Natural Sources	Causes of D Deficiency	Amount of Vitamin D Man and Woman should consume each day
• Milk • Cheese • Yogurt • Salmon • Red meat • Egg • Cod liver oil • Tuna • Liver	• Osteomalacia • Reduced absorption • Rickets • Increased excretion	For adult males – 15 mcg For adult female-15 mcg For pregnant/lactating women- 15mcg

Table 7: Recommendations for a healthy diet for Vitamin D (Farhan Aslam et al., 2017).

Vitamin E: Vitamin E is a group of eight fat-soluble compounds. The liver converts them into alpha-tocopherol, which is vitamin E. Alpha-tocopherol is found in walnuts, seeds, and vegetable oils. Vitamin E is prevalent in leafy greens. It's a potent antioxidant that can affect immune function. Despite the fact that deficiency is rare, supplementation promotes immune function in the elderly (Darbar & Saha, 2020). Vitamin E insufficiency reported reduced levels of DTH, an in vivo marker for cell-mediated immunity, and IL-2, an important cytokine for T cells. Vitamin E therapy reduced pro-inflammatory cytokines while increasing T cell proliferation. Preterm newborns' neutrophils with low vitamin E activity were less bactericidal and phagocytic. The injection of vitamin E restored neutrophil and NK cell activity to adult levels. Several placebo-controlled clinical trials have revealed that vitamin E increases T-cell-mediated activity in the elderly (Lewis et al., 2019). A-tocopherol is the most well-known tool or tocotrienol product in boosting human health. Antioxidants like a-tocopherol are produced in the liver to protect membrane proteins and fatty acids from oxidative damage. The fact that the human body has eight different forms of vitamin E from plants is also vital. According to Niki and Traber, its antioxidant concentration was first called "inhibitols" because it resembled numerous plant-based inhibitols that are neutralized by hydroxyl (OH) group-degrading agents. Antioxidant characteristics of Vitamin E (Niki & Traber, 2012). Vitamin E, in addition to being an immunoregulator, also acts as an antioxidant, neutralizing and suppressing free radicals. Mitogen-induced increases in T-lymphocyte multiplication, cytotoxic cell activity, and macrophage activity against invaders are effective anti-infection strategies. Vitamin E reduces platelet and nitric oxide buildup in macrophages and neutrophils via inhibiting PKC activation (protein kinase C). Vitamin E deficiency causes ataxia, a neurological condition (Zhang et al., 2012). Vitamin E may lower immunosuppressive macrophage-produced prostaglandin PGE2 and hydrogen peroxide, which limits lymphocyte proliferation (Maggini et al., 2018). Vitamin E has also been studied as a preventative strategy for a variety of human illnesses, such as heart disease and cancer (High, 2001).

<table>
<tr><th rowspan="2">Natural Sources</th><th rowspan="2">Causes of E Deficiency</th><th colspan="2">Amount of Vitamin E Man and Woman should consume each day</th></tr>
<tr><td>Male</td><td>Female</td></tr>
<tr><td rowspan="3">• Almonds
• Sunflower oil
• Tomato
• Wheat
• Mangoes
• Broccoli
• Peanuts
• Spinach
• Avocados</td><td rowspan="3">• Ataxia
• Retinopathy
• Weak immune system
• Peripheral neuropathy</td><td>Age 1-3 years- 6 mg</td><td>Age 1-3 years- 6 mg</td></tr>
<tr><td>Age 9-13 years -11 mg</td><td>Age 9-13 years -11 mg</td></tr>
<tr><td>Adults – 15 mg</td><td>15 mg (adults)
15 mg (pregnant)
19 mg (lactating)</td></tr>
</table>

Table 8: Recommendations for a healthy diet for Vitamin E (Farhan Aslam et al., 2017).

It helps fight numerous infections. Vitamin E intake promotes white blood cell proliferation, assists in foreign cell removal, and strengthens the body's resilience to infectious agents and diseases. Vitamin E is a powerful immune system enhancer. Because vitamin E is not oxidized, it has anti-inflammatory and anti-bacterial effects. However, Vitamin E is fat-soluble. Thus, fat in a meal enhances the absorption of this vitamin. Diets strong in starchy foods and low in plants rich in vitamin E are more prone to vitamin E deficiency (Karacabey, 2012).

Chapter 4

Role of Physical Activities in Boosting Immune System

A healthy lifestyle necessitates daily exercise. Age-related immunological dysfunction, persistent low-grade inflammation, and flu vaccine efficacy may all be improved by frequent physical activity for at least six months (Ranasinghe et al., 2020). Regular exercise is essential for good mental and physical health. Preventing and controlling chronic illness are all benefits of regular exercise that may be achieved during this pandemic (Lange & Nakamura, 2020). Restricting physical activity and changing workout routines can help keep the coronavirus at bay. An increase in physical inactivity due to the coronavirus outbreak (Hall et al., 2021). In March 2020, over 90% of South Korean parents report reduced use of play and sports facilities for their young children. You might gain weight if you restrict your physical activity. Boredom and despair may cause overeating. The main benefits of exercising during an epidemic are to protect oneself from the bad effects of inactivity on one's health, especially to improve health and immunity while reducing stress and worry (Guan et al., 2020). The immune system is improved by regular physical exercise, which minimizes the chance of illness. such as URTIs. Various studies have indicated that moderate or intensive exercise improves the immune system (Nieman et al., 2005). Upper respiratory infections, especially viral infections, tend to be decreased with moderate-intensity exercise training. For example, frequent physical exercise reduces the risk of influenza and pneumonia fatalities. On the other hand, exercise can have both favorable and harmful impacts on the immune system (Fierens & Goossens, 2021).

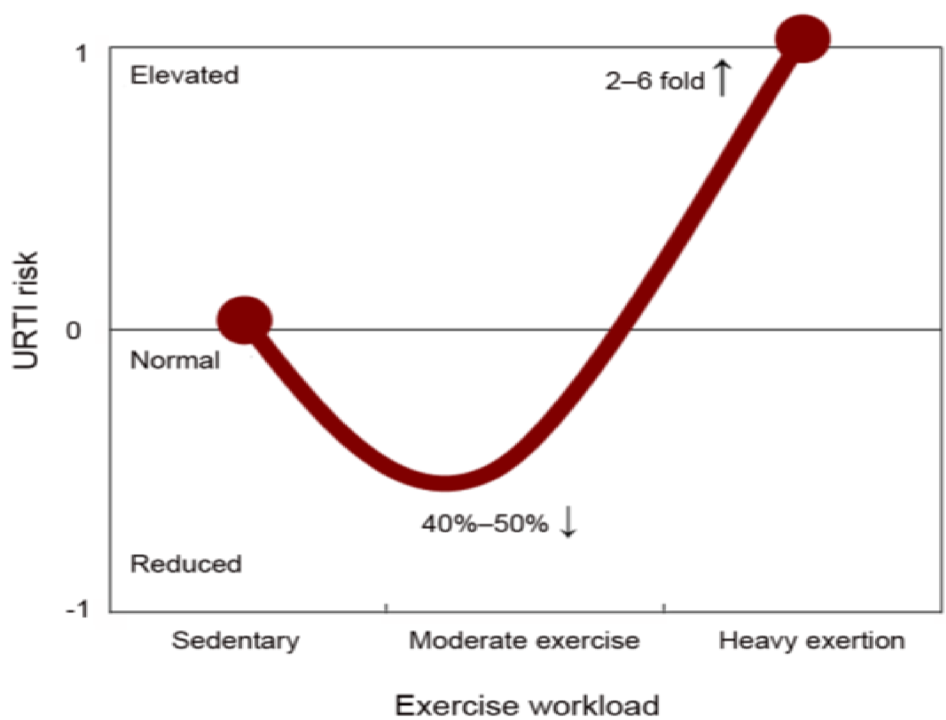

Figure 5: J-curve concept of exercise effort and risk of URI (Monye & Adelowo, 2020a).

Moderate exercise can improve glucose and lipid metabolism (less than 60 minutes daily). Exercise may also improve inflammatory signaling pathways that boost IL-1ra and IL-10 production, and improve oxygenation by lowering dysfunctional adipose tissue. It improves the immune response by increasing the recirculation of immunoglobulins, neutrophils, NK cells, anti-inflammatory cytokines, cytotoxic T cells, as well as immature B cells. Regular exercise improves innate immune activity and metabolic function (Nieman & Wentz, 2019). On the other hand, Intense physical effort, competitiveness, and prolonged high-intensityintensity exercise have been associated with an increased risk of URTIs. A two- to six-fold increased incidence of URTIs up to two weeks and reduced NK cell lytic activity (Nieman & Wentz, 2019). " The "J-shape curve" describes the relationship between illness risk and exercise factors. However, excessive endurance training may weaken the immune system, increasing the chance of sickness (Cox et al., 2008).

Exercises lasting under 45 minutes are advantageous to the immune system, while those lasting over 1.5 hours are negative. Exercise-induced immunomodulation may help spread COVID-19 infection (Engebretsen et al., 2013). High-intensity aerobic exercise is more effective than low-intensity programs in addressing mental health conditions including anxiety disorders. Compared to inactivity, physical activity has a considerably greater impact on depression symptoms (Aylett et al., 2018). Getting some fresh air and a decent workout may be vital to keeping good health while isolated, according to the COVID-19 pandemic. To avoid this outbreak, frequent moderate-intensity exercise is advised (Chen et al., 2020). Regular exercise can help prevent or delay inflammatory illness. A healthy lifestyle reduces the risk of infection by viruses and bacteria. Daily moderate-intensity exercises including walking, swimming, and cycling can reduce URTI symptom duration by 40–50 percent (Scheffer & Latini, 2020). Moreover, Regular physical activity can help maintain a healthy heart, decrease blood pressure, and maintain a healthy weight.

All of these items help improve circulation, which helps the immune system transfer cells and other materials to a damaged organ. (Xiong et al., 2020).

	During Exercise	After Exercise
Neutrophil count	↑	↑ ↑
Monocyte count		↑
Lymphocyte count	↑	↓
CD4+ T cell count	↑	↓
CD8+ T cell count	↑	↓
CD19+ B cell count	↑	↓
CD16+56+ NK cell count	↑	↓
Lymphocyte apoptosis	↑	↑
Proliferative response to mitogens	↓	↓
Antibody response in vitro	↓	↓
Saliva IgA	↓	↓
Delayed type hypersensitivity response (skin test)		↓
NK cell activity	↑	↓
Lymphokine activated killer cell activity	↑	↓
C-reactive protein		↑
Neopterin		↑
Plasma concentration of TNF-α	↑	↑
Plasma concentration of IL-1	↑	↑
Plasma concentration of IL-6	↑ ↑	↑
Plasma concentration of IL-1ra	↑ ↑	↑
Plasma concentration of IL-10	↑	↑
Plasma concentration of TNF-R	↑	↑
Plasma concentration of MIP-1β, IL-8		↑

↑, Increase; ↓, decrease; ↑ ↑, marked increase; TNF-α, tumor necrosis factor-α; TNF-R, tumor necrosis factor receptors; IL, interleukin; MIP, macrophage inflammatory protein.

Table 9: Effect of strenuous exercise on the immune system (Pedersen & Hoffman-Goetz, 2000).

The "Metabolic Equivalent of Task" is calculated by dividing the working metabolic rate by the resting metabolic rate (MET). Low- to moderate-intensity physical activity (MET 2–6) is preferable to sedentary activity (MET ,<2) such as desk work, reading, and writing. But intense physical activity (MET > 6) like sprinting, football, cycling, and swimming is preferable (de Frel et al., 2020). HIIT, when combined with a moderate-intensity, continuous exercise plan, improves metabolic hemostasis and improves heart and blood vessel function. HIIT also improves the immune system (Li et al., 2016). However, prolonged, vigorous, or near-maximal exercise has been linked to increased sickness risk. The most popular workout routines are 30–45 minutes each day, five days a week (Nieman & Wentz, 2019). With acute and long-term exercise and training, increased release of cortisol, catecholamine, and neuropeptides is associated with immune response modifications. When maximal oxygen consumption hits 60%, adrenaline and cortisol levels climb. This is due to vasopressin, which causes the release of CRF and ACTH. Exercise increases lymphocytes via ß2-adrenoceptor-mediated lymphocytic agonist action. It is thought that cortisol works by preventing lymphocytes from entering the body, therefore lowering the neutrophil level (Tabata et al., 1991). Numerous studies have linked regular exercise to better immune function and a delayed onset of immunosenescence (Nieman & Henson, 1994). For the duration of the COVID-19 pandemic, maintaining recommended levels of physical exercise. Following is a daily timetable for quarantine or self-isolation athletes: Workout regimens can be discussed with a coach or fitness professional. In the absence of gym equipment, there are several self-isolating workouts that target the core and limbs. There are various possibilities for endurance training including aerobics and calisthenics (Simpson & Katsanis, 2020).

- Boosted immunity to vaccines.
- Fewer T-cells that are exhausted or senescent.
- Increased T-cell proliferative capacity.
- Lower levels of inflammatory cytokines in the bloodstream.
- Enhanced neutrophil phagocytic simulation.
- Reduces the inflammatory reaction when pathogens are attacked.
- NK cell cytotoxicity has enhanced.
- Longer leukocyte telomeres lengths.

Chapter 5

Role of Some Lifestyle Factors in Immune System

Several lifestyle factors impact our immune systems. Genetics and lifestyle variables change physiology, causing illnesses such as heart disease, obesity, renal disease, and diabetes. Because lifestyle is the root cause of many diseases, it should be part of their treatment approach. This suggests that lifestyle factors may directly influence immunity. It depends on several factors (de Frel et al., 2020). Now, we will discuss some important lifestyle factors below:

Sleep: Sleep appears to be vital to the immune system. However, both the innate and adaptive immune systems are impacted by sleep. To minimize the risk of infection, increase vaccine responses, and prognosis of illnesses, the immune system is thought to boost host defense (Besedovsky et al., 2019). Insufficient sleep lowers the body's immunity, making it more susceptible to sickness. Anxiety, stress, and sleeplessness can worsen inflammatory conditions. Shorter sleep durations after an intranasal rhinovirus challenge may increase common cold exposure (Lange & Nakamura, 2020). Research shows that sleep deprivation affects numerous aspects of the body immunity, including cytokine levels and cell subpopulations (such as IL-1, CD8+, TNF-a, NK cells, CD4+ as well as IFN-g. It increases the production of IL-1 and IL-2. Additionally, sleep has an effect on the generation of IL-2 by T-cells (Ibarra-Coronado et al., 2015). Less than six hours of sleep every night increases viral infection risk and shortens lifespan (Haspel et al., 2020). No of how much sleep you get, pro-inflammatory markers including IL-6, CRP, and TNF are known to increase. Encouraging cardiovascular exercise and healthy eating habits are two ways to reduce IL-6 and CRP (Gurley, 2019). People who do not get enough sleep produce less of a protein called cytokines that fights both infection and inflammation (Bryant et al., 2004). The centrally produced cytokines that are regulated by enough sleep affect one's immune response. As a result, getting a decent night's sleep is critical. Age and gender apart, individuals need between 7 and 9 hours of sleep every night (Hirshkowitz et al., 2015).

Sleep deprived COVID-19 patients have increased CXCL9, a lymphocyte infiltrating molecule. Inflammasome activation is linked to COVID-19. NLRP3 Even during viral sickness, melatonin, an anti-inflammatory molecule, may help reduce coronavirus virulence by preserving lung tissue integrity and lowering inflammation (Alschuler et al., 2020). Sleep deprivation impacts antibody titers post-vaccination. Following H1N1 vaccination, one night of total sleep deprivation had a short-term but significant influence on men's antibody titers compared to well-rested males (Benedict et al., 2012; Spiegel et al., 2002). Shift work, nighttime light exposure, and social jet lag all cause circadian rhythm disruption (Haspel et al., 2020). Screen use is currently the leading cause of sleep disruption. Gaming, TV, computers, and mobile devices may interrupt sleep. Non-school days saw kids less active and sleepier. Screen time should replace exercise. Fluorescent lighting at night affects melatonin levels, affecting sleep and other physiological activities. Electronic light may disrupt sleep. Comparatively, reading an eBook lowers tiredness, melatonin production, delayed circadian rhythm, and morning alertness (Lange & Nakamura, 2020).

Smoking: Tobacco use has been linked to greater infectious disease mortality. Studies show that tobacco smoking may raise the risk of sickness, poor prognosis, and mortality among infected persons, either directly or indirectly (WHO EMRO | Tobacco and Waterpipe Use Increases the Risk of COVID-19 | Know the Truth | TFI, 2020.). Smokers' immune systems are compromised by nicotine and other tobacco components that have inflammatory or anti-inflammatory characteristics. Smokers or former smokers of COVID-19 are more prone to severe sickness. Smokers had a 40% reduced chance of severe symptoms, but a 140% higher risk of being hospitalized, needing artificial respiration, or dying during treatment (Komiyama & Hasegawa, 2020). In individuals with a history of smoking, tobacco use was connected to a 14% increased risk of pneumonia and an 11% greater risk of stage III disease progression. Smokers were 14 times more likely than non-smokers to die prematurely. Smoking has been found to harm the respiratory system at every level. It also affects mucociliary clearance, which allows the nasal cavity to remove foreign material from the upper airways (Monye & Adelowo, 2020). Angiotensin-converting enzyme 2 is one of the viral components that allows SARS-CoV to enter and multiply in host cells. In both the big and small airway epithelia, current smokers have higher levels of ACE2 gene expression than never smokers. Another study found the ACE2 gene elevated in the airways of current smokers (Lange & Nakamura, 2020). Over five times as many smokers developed influenza and 34% more smokers had influenza-like sickness than nonsmokers (Vardavas & Nikitara, 2020). Tobacco smoking may also decrease the innate immune system, resulting in a poor response to all infections. Researchers using nasal scrape biopsies from nonsmokers and smokers found widespread gene-level immunosuppression in tobacco users. After only 20 puffs, e-cigarette users' alveolar macrophages increased gene expression by over 60 genes, Smokers who touch their lips with their fingers may increase their risk of getting COVID-19 (Reduce Your Risk of Serious Lung Disease Caused by Corona Virus by Quitting Smoking and Vaping | Center for Tobacco Control Research and Education, 2020.). As a result of these research, it has been shown that quitting cigarette smoking is linked to better health outcomes for probable comorbid illnesses, such as cardiovascular disease as well as diabetes mellitus(Monye & Adelowo, 2020).

For a variety of reasons, smokers are more prone to respiratory tract infections. Smoking increases the risk of getting or transmitting TB (Leary et al., 2014). Smoking increases the risk of some of the most common bacterial infections that infect the lungs of adults include *Streptococcus* *pneumoniae* and *Neisseria meningitides* as well as the flu-causing bacteria *Haemophilus influenzae* and *Legionella pneumophila*.

Consume Alcohol: Many civilizations permit alcohol intake. The consciousness of the negative impacts of consumption improves public health (de Frel et al., 2020**).** Alcohol has no good health impacts and is a substantial vital cause of chronic diseases as well as damage. It is one of the vital reasons of liver diseases worldwide. All-cause mortality increases as the quantity of alcohol taken increases and full abstinence are the only way to reduce the risk(Lange & Nakamura, 2020). Alcohol affects both innate and adaptive immune cells, impairing the immune system's ability to respond to illness. Alcoholics are also more prone to getting community-acquired pneumonia. Although alcohol is harmful to human health, it is equally harmful to animal models of lung infection (Szabo & Saha, 2015). Alcohol intake has been related to an increased risk of viral illnesses like COVID-19. Alcohol use has been linked to immune system impairment. ARDS, a possible COVID-19 complication, has been associated to excessive alcohol use, especially heavy drinking. It may also affect judgment and decision-making, which may be significant to the care of COVID-19 patients in isolation (WHO, 2020). Physical distancing, lockdown, self-isolation, and self-isolation are all criteria for infection management that may be affected by alcohol use. That's why, consuming Alcohol should be stopped during this pandemic (Monye & Adelowo, 2020). This study found that frequent alcohol drinking raises the risk of pneumonia by 8% per unit. The body is anti-inflammatory for the first twenty minutes and pro-inflammatory for the next five hours after a strong drinking session (Szabo & Saha, 2015).

Stress Management: The neurological system alters both adaptive as well as innate immunity, and sickness severity and susceptibility are linked to emotional reactions to psychological stimuli (Bailey, 2016). A person's ability to respond to sickness is hampered when they are under a lot of stress. To cope with everyday challenges, our bodies and minds naturally produce stress hormones (Monye & Adelowo, 2020). The hypothalamus-pituitary-adrenal (HPA) system governs cortisol production and release. Cortisol is involved in stress response, metabolic control, inflammatory and immunological function. Chronically high cortisol levels can reduce the body's ability to fight illness. Stress hormones cause the immune system to malfunction (L et al., 2019). Decreased catecholamines, suppressor T cells, and proinflammatory cytokines like IL-6 are associated to increased cortisol (Abdurachman & Herawati, 2018). Stress has been linked to an increase in the risk of forming diseases for developing clinical symptoms during experimental respiratory virus infection, type 2 diabetes, viral infections, heart disease, , asthma as well as stomach ulcers (Monye & Adelowo, 2020b). Stress-reducing psychological therapies have been shown to improve the immune system, according to a meta-analysis of studies on this topic. A stronger immune system was shown to be associated with more frequent use of self-reported stress reduction techniques. (Schakel et al., 2019). Stress causes histamine release, which can lead to bronchus constriction and respiratory difficulty. Poor stress management, less sleep, excessive drinking and smoking may have a negative impact on immune function (Abdurachman & Herawati, 2018). Patients with COVID-19 who were evaluated psychologically showed up to 48% of early-admission stress, mostly due to their emotional reaction to the illness, the study found. Stress Disrupts their immune system and aggravates their illness. In order to avoid or manage stress in COVID-19 patients, doctors recommend evaluating them for psychological stress (Tingbo, 2020).

Some ways to reduce stress:

- Favorite music, videos, as well as movies might help reduce tension.
- Talking to a trustworthy person might help ease fear or sadness.

- Use verifiable sources for information like the WHO. stress by Limiting watching negative news, recent politics, and unpleasant drama.
- Be positive and understand that we cannot control circumstances.
- You may also use relaxation applications or internet tools to help you relax.

Maintain a Healthy Diet: Chronic overeating of ultra-processed energy-rich (junk food) and nutrient-deficient meals and beverages causes systemic low-grade inflammation. External or endogenous stimuli that modify innate immune cells may induce "trained innate immunity”. This innate memory raises the inflammatory set point of innate immune cells via changes in their progenitor cells. Epigenetic changes early in the development of immature innate immunity boost the expression of pro-inflammatory genes. Nothing is known about enhanced intrinsic inflammation and reduced adaptive immune activation against pathogens. Stimulated myeloid cells or T- and B-cells can suppress the immune system or change adaptive responses (de Frel et al., 2020). Lifestyle risk factors including smoking and obesity increase epigenetic aging. Obesity reduces T-lymphocyte production, speeding up immunosenescence. Inflammation is reduced by a diet rich in fruits and vegetables (Levine et al., 2018). Fasting or intermittent fasting has been demonstrated to help persons with co-morbidities, such as chronic diseases, and to prevent disease in healthy people by reducing oxidative stress and inflammation. Restriction of caloric intake reduces oxidative stress, inflammation, and metabolic disease markers. Fasting (as during Ramadan) or intermittent fasting may help boost the immune system (Yousfi et al., 2020). Proper diet may help lessen the impact of new infections. The immune system is compromised by extreme calorie restriction and malnutrition. Extreme calorie restriction and crash diets should thus be avoided (Collins, 2020).

Consumption of vegetables, fish, nuts, fruits, legumes, and 'good' fats reduce the risk of chronic non-communicable diseases and improves immune function. Various nutrients and bioactive chemicals may explain this connection. Probiotics, polyphenols, and zinc may benefit autoimmune and inflammatory illnesses (Childs et al., 2019). On the other hand, Nutritional deficiency has been linked to an increased risk of noncommunicable diseases and decreased immune function in those who consume a diet rich in energy-dense foods (Myles, 2014).

Psychological well-being & Social connection: Immune system function is linked to both psychological well-being and social connectivity, with the former being related to increased resistance to disease, particularly infectious diseases, and the latter being associated with poorer immunity (Abdurachman & Herawati, 2018). COVID 19 patients reported feelings of remorse, rage, helplessness, despair, tension, phobias, irritability, loneliness, and sleep deprivation. These psychological disorders may impair the body's capacity to fight illness (Tingbo, 2020). Having a partner improved the immune response of Alzheimer's sufferers, according to research. People who were socially connected had a positive immune response, which was linked to positive psychological changes (Abdurachman & Herawati, 2018). Study findings reveal that those with a negative emotional style have a weaker immune system and a greater chance of developing infectious illnesses than those with a positive affective style, according to a meta-analysis(Monye & Adelowo, 2020a). A better immunological response to infections is reflected in higher levels of psychological well-being and social relationships. Social connections typically cause emotional arousal, which helps the body fight infections by reducing inflammatory indicators including interleukin-1 receptor antagonist, sTNF-RII, and CRP. This may reduce infection frequency and severity (Abdurachman & Herawati, 2018). Religious coping and social connection have been demonstrated to benefit HIV/AIDS patients' psychological well-being, which in turn benefits their immune response. Depression, for example, has been linked to a reduced cellular immune response, resulting in slower infection recovery and wound healing (Monye & Adelowo, 2020a).

- Always look for the positive aspects of life and concentrate on the things that make it worthwhile to be alive.
- Consider the things for which you may be grateful and joyful.
- Remain upbeat and hopeful in the face of difficulties and concentrate on your own goals/strengths.

Discussion

Since the outbreak of covid-19, Peoples has been adversely affected on a worldwide scale, both socially and mentally. In terms of the reality that the WHO has declared Covid-19 as a pandemic, Researchers have been searching for various strategies to combat it. Unfortunately, till now there has been no established treatment for this disease. So, we have to prevent this infection for this we have to make our immune system strong so that we can fight against this virus. Medicines can improve our immune system but some medicines have some adverse effects also so we have to choose the natural way to boost our immune system. We have to focus on our daily lifestyle. A healthy lifestyle can boost your immune system by activating your T-cell, B-cell and other important elements of the immune system. Despite the fact that there are no foods or supplements that may prevent or treat COVID-19 infection, nutritious diets are essential for boosting the immune system. Obesity, heart disease, diabetes, and certain kinds of cancer may all be prevented by eating a healthy diet. Mainly, covid-19 and other virus and bacteria try to attack on our body but our body defense system prevent their activity so that those micro-organisms will fail to do any harm to our body. However, when our immune system is weakened, that cannot perform properly to inhibit the microorganism activity so that those microorganisms can easily affect us and makes us sick. In order to make our immune system stronger we have to change our lifestyle. Many nutrition-like vitamins, minerals, proteins are important elements that have a significant role on those immune cells. They are helps to activate the immune cells and maintain a better immune response activity. That's why, when microorganism like virus and bacteria enter our body, our immune system triggers very quickly and inhibits their harmful activity. Besides, High carbs, added sugar, fat-rich food mainly the immune system is negatively impacted by eating junk food, they are making our immune response slow and weak so that the immune cells can not properly inhibit the microorganisms. Here there is a daily food intake plan an adult:

Food group	**g/Portion**	**Sedentary**	
		Man	**Women**
Cereals & Millets	30	12.5	9
Pulses	30	2.5	2
Milk & Milk Products	100ml	3	3
Roots & Tubers	100	2	2
Green Leafy Vegetables	100	1	1
Other Vegetables	100	2	2
Fruits	100	1	1
Sugar	5	4	4
Oil & Fats	5	5	4

Table 10: Daily ideal food intake plan for an adult (Manual, 1998).

Moreover, Physical activities are also very beneficial for our body. Regular exercise may enhance flexibility, balance as well as endurance. Exercise may help avoid stroke, obesity, heart disease, diabetes as well as hypertension. Regular weight-bearing exercise helps prevent osteoporosis by strengthening bones. It helps to keep our body fit, maintain a proper weight that is also helpful for the immune system. It helps to increase our stamina and increase our blood circulation, that helps our important organs like heart, kidney, brain etc perform properly as well as accurately. That also makes our immune cells more powerful so that those T cells a & B cells performs accurately and faster against the pathogens. Furthermore, Other lifestyle factors like proper sleep, maintaining a good social connection have a very effective role in the immune system. It helps to makes us physically and mentally strong and fit. However, smoking, consuming alcohol, stress have no positive value in our body but they have negative effect on our immune system. They lead to damage our important body organs as well as reduce the immune cells production. Moreover, they are the main reason for many disease-like lungs disease, liver disease, neurological disease, cancer, etc. So, we also avoid those bad habits for a healthy lifestyle.

According to Dr. Charles Patrick Davis here is some guideline to maintain a healthy life style (Healthy Living Facts, Diet and Exercise Tips & Tools for Success, 2021).

- Breakfast, lunch, and supper are the three most essential meals of the day, but supper doesn't have to be the heaviest one.
- Healthy foods including Vegetables, fruits, whole grains as well as low-fat milk products should make up the majority of your diet.
- Minimize sodas as well as sugar-enhanced beverages due to their high-calorie content; diet drinks are not really a smart option since they increase hunger and food intake.
- Manage food portions; eat as the minimum amount that can satisfy your appetite and then quit.
- Make sure to consume enough lean protein sources such as fish, egg, chicken breasts, turkey, beans as well as almonds.
- Any meat that has been eaten raw or undercooked should be avoided.
- Vegans should consult their doctors to ensure they are receiving adequate vitamins, iron as well as mineral's.
- Reduce weight gain and gastric reflux by avoiding a heavy meal before bedtime.

- If you consume raw foods such veggies and fruits, wash them well with purified water shortly before eating and properly cook your food with high temperature.
- Completely stop smoking and consume alcohol.
- Exercising for 30 minutes 3–5 days a week is advised, although exercising most days a week provides the most health advantages.
- Do household work as regular exercise by everyday tasks including climbing stairs, cleaning, opening jars as well as cycling.
- Minimum daily 7-8 hours' sleep is necessary for health.
- Sports for kids may be great for fitness, but be careful not to overdo it.
- Those who have a great social network are more likely to live longer and healthier lives.
- Have fun. Spend your vacation time with loved ones, shopping, or fishing.
- Experience something different at least once a week, whether it's to eat something new, take a different path to work, or see a new exhibit at a museum.
- Try to sleep earlier in night and wake up early in morning.
- Use electronic devices as less as possible,

Therefore, A healthy lifestyle should maintain not only in this pandemic but also other times for a better immune system. This is vital in the battle against infections.

Conclusion

In this Review Article, there is a brief description of how our lifestyle affects our immune system. Immunity is the most critical aspect of our body. It saves us from various kinds of infections and diseases. Therefore, we should always be concerned about our body's immunity. In Addition, during this Pandemic People throughout the globe are dealing with a dangerous set of circumstances because of corona virus outbreak. The immune system must be strengthened during this time is the most important thing. Because there is not any approved proper treatment for this virus. There are several unhealthy behaviors that can result from COVID-19-related confinement at home, including increased screen time, which is causing sleep disturbances and leading to imbalanced high-calorie meals, all contribute to an increasingly sedentary lifestyle and decreasing physical activity. The growth of non-communicable diseases is connected to all of these practices, which may weaken immunity. Healthier lifestyle choices can reduce the risk of infection during this time period. A balanced and healthy diet builds a robust immune system. The immune system and its ability to combat infection are impacted by malnutrition and hunger as well as Western-style energy-dense meals. A nutritious diet may therefore help individuals maintain a healthy weight and avoid chronic illnesses. Additionally, we should do some minimum physical activity regularly which makes the body fit and strong and also have a positive effect on sleep habits. As well as, Good sleep is essential for a strong immune system. Moreover, smoking quitting as well as alcohol consumption reduction are crucial steps in enhancing immune system function and coping with infection. Furthermore, Social connection and psychological factors also affect immunity so that we should always be stressless and build a good relationship with others. To Summarize, we should change our sedentary lifestyle to an active healthy lifestyle to boost our immune system and hence prepare to fight against deadly infections.

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