



## Diet and immune system

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### Key point

The immune system protects versus illness. Exposure to contaminations, stress, malnutrition and other factors that impact on immune dysfunction has increased in the modern lifestyle hence paying attention to adequate amount of calorie, protein, vitamins, minerals and antioxidants is necessary.

### Introduction

The immune system that consists of several biological constitutions and activities protects versus illness. This system can be categorized into the humoral immunity versus cell-mediated immunity or innate immune system versus the adaptive immune system. The innate immune system, which consists of mechanical (the mucous membranes and skin), chemical (enzymes), and biological (pH, temperature, and oxygen levels) barriers, has an imperative role as the first-line protection against external organisms and materials. The adaptive immune system is antigen-specific and consists of specific types of leukocytes, called lymphocytes (1). Although the exposure to microorganisms in the modern lifestyle has reduced, exposure to contaminations, levels of stress, and other factors that impact on immune dysfunction has increased and it is distinct that the modern diet similarly injures the immune system (2). Nutrition has an intense impression on immunity and healthiness. Nutritional deficiencies weaken immune system and, thus, increase disease and mortality. Prolonged undernutrition and micronutrient deficiency affect cytokine response and immune cell trading. The combination of chronic infection and malnutrition impairs the immune reaction, causes distorted immune cell amount, increases inflammatory intermediaries, reduces leukotrienes, weakens bacterial ingestion and killing. The general influences might include changed microbial colonization of mucosal surfaces and weakened host reaction to new pathogens (3,4). Likewise, both the reduction macronutrients and micronutrients in undernutrition cause immune destruction (3). The protein calorie malnutrition (PCM) more impacts

on cellular immune system than the humoral immune system, however micronutrient deficiencies will affect the adaptive immune system, as well as the innate immune response (5).

### Calorie and protein

Consumption sufficient calorie and protein is necessary for optimum immune function and insufficiency in them, strictly decreases the immune system's capacity to respond, impairs the construction and function of the thymus, and decreases T-cell memorial reaction to antigens (6).

### Sugars

In vitro evidence advocate simple sugars decrease white blood cell phagocytosis and probably rise inflammatory cytokine indicators in the blood, however, the complex carbohydrate fiber (but not starches) decrease inflammation in humans (7).

### Salt

Animal studies show that high intake of salt might rise IL-17-intermediated inflammation and worsen autoimmune disorders (8).

### Saturated fatty acids

Saturated fatty acids can destructively influence on immune system by enhancing the prostaglandin system that convert to the arachidonic and prostaglandin E2 (PGE2). PGE2 is pro-inflammatory, increases IL-17 amount, and activates macrophage by other pathways. Also, dietary fats by changing the lipids of the membranes of immune cells, can disturb the immune functions (9).

### Omega-3 fatty acid

Omega-3 (n-3) poly-unsaturated fats have

anti-inflammatory impressions. Omega-3 fatty acid can convert to eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) that are precursor of anti-inflammatory mediators such as resolvins and protectins. These mediators decrease inflammation, stimulated neutrophil infiltration, boost the sifting of inflammatory chemokines, and improve macrophage phagocytosis to disappear apoptotic cells (6,10).

### Vitamins

Some studies indicate that vitamins can considerably change macrophage phagocytosis and several of its component phases. Also can improve the production of cytokines such as tumor necrosis factor (TNF- $\alpha$ ), interleukin (IL-1 and -6), inflammatory mediators such as prostaglandin E2 (PGE2), and interferon (IFN).

### Vitamin A

Vitamin A has a vital role in the improvement of healthy immune responses. Vitamin A and its metabolites (particularly retinoic acid [RA]) play a great role in the control of both innate and adaptive immune responses (11). Vitamin A by impact on the integrity of mucosal epithelia (12), the diversity, quantities, and cytokine secretion profiles of macrophages, monocytes, neutrophils, and natural killer cells improve innate immune responses. Also by developing, maturing the thymocytes, increasing the quantity of T-cells, specifically the CD4+ subpopulation has effect on adaptive immune responses (13,14).

### Vitamins C and E

Vitamins C and E supplementation increase neutrophil adherence, natural killer cell activities, phagocytic capacity, lymphocyte proliferation, and chemotaxis and decrease superoxide and oxygen free radicals production by neutrophils (15).

### 1,25-Dihydroxyvitamin D

1,25-Dihydroxyvitamin D (1,25(OH)<sub>2</sub>D) modulate the function of human immune reactions by impressing on lymphocytes and adaptive immunity; however, investigation have revealed that vitamin D probably influences on innate immunity (16).

### Trace elements

The association between trace elements and macrophage functions seems to be as vital as vitamins.

### Zinc

Several disease progressions lead to zinc deficiency and low plasma amounts of zinc cause weakened immune function. Supplementation with zinc stimulated cytokine production, mainly IL-1, IL-6, and TNF- $\alpha$  (17).

### Selenium

Selenium improved the bactericidal and phagocytic functions of human neutrophils in vitro. Selenium dietary deficiency increased tumor cytotoxicity, macrophage inflam-

matory action and PGE2 production in Rat (18).

### Copper

Deficiency of copper in the diet decreased the amount of circulating neutrophils and damaged their function in humans (19).

### Iron

The ability of neutrophils to kill bacteria decreases in iron deficiency (20).

### Conclusion

Sufficient macronutrient and micronutrients are essential for immune system function.

### Conflicts of interest

The author declared no competing interests.

### Author's contribution

MK was the single author of the paper.

### Ethical considerations

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the author.

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