EXPERT OPINION

Nutrition for Optimal Immune System Health

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Adequate and appropriate nutrition is vital for optimal functioning of all cells, including immune cells[1]. Optimal nutrition helps immune cells initiate effective responses against pathogens, respond rapidly when needed and prevent chronic inflammation[1].

Certain micronutrients and dietary components play specific roles in developing and maintaining an effective immune system and reducing chronic inflammation[1].

Excessive intake of certain micronutrients can also impair immune responses, such as iron supplementation increasing morbidity and mortality in malaria-endemic regions[1].

GUT-ASSOCIATED LYMPHOID TISSUE

The gut-associated lymphoid tissue (GALT) houses a majority of immune cells in the human body, underscoring its significance in maintaining overall host health[1]. The gut lumen contains the human gut microbiome, which provides antigens and signals that can interact with local and systemic immune cells[1]. The composition of the gut microbiome changes throughout life in response to dietary factors and environmental influences like antibiotic use[1].

Several nutrients and dietary interventions have shown promising effects in improving gut health and reducing inflammation[1]. The Mediterranean diet, characterized by consuming vegetables, fruits, nuts, legumes, fish, and healthy fats, has been associated with a lower risk of chronic diseases such as cardiovascular disease, cancer and Alzheimer's disease[1]. Fruits and vegetables contain bioactive compounds, including dietary polyphenols, that have immunomodulatory and anti-inflammatory properties[1].

THE MINERALS ZINC AND SELENIUM

Zinc is a cofactor in numerous proteins, and even a mild deficiency can impair both the adaptive and innate immune response. During sepsis, zinc homeostasis is disrupted, which has implications for therapeutic strategies in septic patients[1].

Selenium plays crucial functional, structural and enzymatic roles in various proteins, and maintaining optimal selenium status is vital for immune function and reducing the risk of chronic diseases such as cancer and cardiovascular disease[1].

VITAMINS

Vitamin A plays a crucial role in regulating both innate and cell-mediated immunity[2]. Its deficiency leads to increased susceptibility to infections and impaired immune function[2]. Vitamin A deficiency affects cytokine release, antibody production and the function of various immune cells[2]. Vitamin A promotes the expansion and differentiation of Th1 and Th2 cells, regulating the balance between pro-inflammatory and anti-inflammatory responses[2]. Retinoic acid, a form of vitamin A, is involved in numerous biological activities and can impact intestinal inflammation and macrophage activity[2]. Vitamin A administration has been beneficial in reducing mortality from diarrheal diseases and has shown potential antitumor effects in various cancers[2].

The B vitamins, including B1, B2, B3, and B12, play essential roles as co-enzymes in various metabolic pathways and cellular functions[2]. Vitamin B1 or thiamine, has antioxidant properties and can inhibit cytokine synthesis and antimicrobial oxidative reactions[2]. It regulates immune metabolism by balancing glycolysis and the tricarboxylic acid cycle[2]. Deficiency in vitamin B1 can lead to pro-inflammatory cytokine expression, neuroinflammation and neuronal death[2]. Thiamine has potential therapeutic applications in neurodegenerative diseases[2].

Riboflavin (vitamin B2) exhibits anti-inflammatory and antioxidant properties and activates mucosa-associated invariant T cells[2].

Vitamin B3 (niacin) functions as a precursor for nicotinamide adenine dinucleotide (NAD) and nicotinamide adenine dinucleotide phosphate (NADP) cofactors involved in redox reactions, and it has anti-inflammatory effects through inhibition of the nuclear factor-kappa B pathway[2].

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Vitamin B12 (cobalamin) affects pro- and anti-inflammatory responses, and its deficiency is associated with altered immune cell populations, hyperhomocysteinemia, insulin resistance and potential links to certain cancers[2].

Vitamin C acts as an antioxidant, regulates immune functions and has anti-inflammatory properties[2]. It can inhibit pro-inflammatory cytokines, enhance anti-inflammatory markers, modulate immune cell activity, and potentially aid in the defense against microbial pathogens[2].

Vitamin D exerts anti-inflammatory effects through its interaction with receptors and signaling pathways[2]. It can inhibit pro-inflammatory cytokines, regulate immune cell responses and contribute to the defense against infections[2]. Additionally, vitamin D has been associated with anticancer effects, including apoptosis stimulation, suppression of cancer cell proliferation and inhibition of pro-inflammatory signaling pathways[2].

MACRONUTRIENTS

Arginine, an amino acid, is crucial to immune system function[2]. It is involved in producing nitric oxide, which is important for macrophages in combating pathogens. They also play a role in the regulation of cytotoxicity by macrophages and have implications for pathogen recognition[2]. The enzyme arginase-1 (Arg-1) may be involved in reducing inflammation through its anti-inflammatory action[2].

Tryptophan is essential for the activity of the immune system[2]. Tryptophan metabolism and its metabolites can influence immune signaling and metabolic pathways, and the balance between kynurenine and tryptophan can have anti-inflammatory effects[2]. The kynurenine pathway regulates inflammation, mediated by enzymes such as indoleamine 2,3-dioxygenase and tryptophan 2,3-dioxygenase. The kynurenine/tryptophan ratio may be a marker for inflammation in various conditions[2].

Glutamine, a nonessential amino acid, is an energy source and precursor for nucleotide synthesis, vital for rapidly dividing immune cells during immune responses[1]. It plays a role in the functions of immune cells and is depleted in critical illness, highlighting the potential for clinical nutrition supplementation in critically ill patients[1].

THE ROLE OF CHOLESTEROL AND FATTY ACIDS IN THE IMMUNE RESPONSE

Cholesterol plays a critical role in immune responses, particularly in the functionality of cellular membranes, especially the plasma membrane[2]. It is essential for maintaining membrane integrity, fluidity and receptor arrangement. An imbalance in cholesterol levels can lead to the deposition of lipid plaques, triggering an inflammatory process[2].

Omega-3 fatty acids eicosapentaenoic acids and docosahexaenoic acids are essential for promoting the resolution of inflammation, including in the respiratory tract[3]. Consuming an adequate amount of these fatty acids produces anti-inflammatory metabolites, which help alleviate inflammation[3].

In conclusion, nutrition and immune function have a strong and dynamic relationship[2]. Nutrients are crucial in modulating immune function through pro-inflammatory and anti-inflammatory effects[2]. Micronutrients such as vitamins A, B1, B2, B3, B12, C, and D and minerals like zinc and selenium can influence both innate and adaptive immunity through genetic, biochemical and signaling pathways[2]. These nutrients can impact immune cells' proliferation, cell division, mobilization, and overall physiology[2].

Furthermore, certain macronutrients like tryptophan, arginine, cholesterol and polyunsaturated fatty acids have also been implicated in preventing and treating immune-related diseases[2].

REFERENCES

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