Immunomodulatory Effects of Omega-3 Fatty Acids: Mechanistic Insights and Health Implications

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Abstract

Omega-3 fatty acids play a significant role in immunomodulation, with nutrigenomic approaches highlighting their impact on gene expression related to immune responses. Research indicates that omega-3 fatty acids can modulate inflammatory pathways, potentially reducing chronic inflammation and enhancing immune function. This review discusses the intersection of nutrigenomics and nutriepigenomics, focusing on how omega-3 fatty acids influence gene expression, immune function, and overall health. The immune system is a complex network responsible for defending the body against pathogens and maintaining internal balance. Comprised of innate and adaptive immunity, the system involves various cells, tissues, and organs working together to combat infections and prevent diseases. Omega-3 polyunsaturated fatty acids (PUFAs), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), play a significant role in modulating the immune system. These fatty acids influence immune cell function, membrane fluidity, and signaling processes, enhancing immune responses and reducing inflammation. Furthermore, EPA and DHA affect several signaling pathways, reducing the expression of proinflammatory cytokines and inhibiting nuclear factor kappa-light-chain-enhancer of activated B cells (NF-kappa B) activation, a critical transcription factor in the inflammatory response. Additionally, they activate PPAR-gamma, further diminishing inflammatory gene expression. As precursors to specialized proresolving lipid mediators, EPA and DHA help shift the lipid mediator profile from proinflammatory to antiinflammatory derivatives, thus aiding in the resolution of inflammation.

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