

# OMEGA FATTY ACIDS IN HEALTH AND DISEASED STATE - A REVIEW

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**Abstract:** *The dietary lipids have a significant job in tweaking the onset of autoimmunity, cardiovascular diseases and cancer. Several studies have been led to build up the adverse impacts of saturated fats in humans and animals. The intake of oils containing both monounsaturated omega-9 and polyunsaturated fats in essentially emerging over certain nations. Yet, the increased uptake of certain vegetable oils of  $\omega$ -6 series is anyway to be seen as proinflammatory and it is one of the potential causes for the steady ascent in some malignant tumors, rheumatoid arthritis and autoimmune disease that are basically caused because of the increased production of proinflammatory cytokines. Diets dependent on  $\omega$ -6 enhanced oils can elevate the level of linolenic acid in tissue phosphoglycerides and can lessen cholesterol levels. Yet these lipids tend to increase unnecessary rise of arachidonic acids. In contrast,  $\omega$ -3 fatty acids-enriched fish oils or omega-3 precursors from certain vegetable oils are found to give protection against cardiovascular disease, rheumatoid arthritis, cancer and against the seriousness of some viral diseases.*

**Keywords:** *Omega-3 fatty acids, Cardiovascular disease<sup>4</sup>, Coronary Heart Disease, Atherosclerosis.*

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## 1. INTRODUCTION

Omega -3 fatty acids which are also called Omega ( $\omega$ ) oils and n-3 fatty acids, are polyunsaturated fatty acids(PUFA) that are characterized by the presence of double bond three atoms away from the terminal methyl group in their chemical structure (1). The PUFAs are a long chain of carbon atoms containing carboxyl group at one end of the chain and methyl group at the other end of the chain. The PUFAs are distinguished into saturated fatty acids and monounsaturated fatty acids with the presence of two or more double bonds between carbons within the fatty acid chain. The major classes of omega fatty acids which is polyunsaturated fatty acid (PUFA) are the omega-3 and omega-6 fatty acids (2). There are about 10 kinds of fatty acids and the ones with physiologically important are  $\alpha$ -linolenic acid (ALA), linolenic acid, arachidonic acid (AA), Eicosapentenoic acid (EPA), and Docosahexaenoic acid (DHA) (3) . The two crucial ones EPA and DHA are primarily found in certain fish. ALA (alpha linolenic acid), another omega-3 fatty acid is found in plant sources such as nuts and seeds(4).

Omega-3s fatty acids play an important role in the human body. It makes up the components of the phospholipids forming structures of the cell membrane. DHA is present in high levels in the retina, brain and sperm (5). It plays an structural role in the cell membranes. Omega-3s and Omega-6s fatty acids provide energy for the body that uses Eicosanoids signalling molecules that are similar chemical structures to the fatty acids (6). It has wide ranging functions in the cardiovascular system, pulmonary system, immune system and the endocrine systems. The Eicosanoids are the potent mediators of inflammation, vasoconstriction and for platelet aggregation. Both classes of fatty acids compete with the

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same desaturation enzyme, ALA which is a competitive inhibitor of linoleic acid metabolism (7). EPA and DHA compete with Arachidonic acid for the synthesis of eicosanoids balance which leads to less inflammatory activity. omega -3 fatty acids also have positive effects on cancers, Alzheimers disease, Diabetes, Dementia and in visual and neurological development.

This review is done to give an outline of omega fatty acids and its uses, and how its used in health and in diseased state. And also how it helps as a tissue membrane phospholipids, manages atherosclerosis, coronary heart disease (CHD), and its cardiovascular effects, management of myocardial infarction and helps in inflammation disease and behavioral disorders (8).

## **2. DISCUSSION**

### **N-3-Fatty acids**

The N-3 fatty acids / Omega-3 fatty acids are polyunsaturated fatty acids that are characterized by the presence of a double bond three atoms away from the terminal methyl group in their chemical structure. They play an important role in the human diet and in human physiology. The mammals are unable to synthesize the essential omega-3 fatty acids and can obtain them through diet. The Eicosanoids are biologically active substances that are synthesised from the long chain metabolites of linoleic acids and  $\alpha$ -linolenic acid (9). The substances that are derived from the n-3 family tend to have less potent inflammatory and immunological effects than those from the n-6 family (10) . This has led to the interest whether there is a role for fish oils which are rich in very long chain n-3 fatty acids in treatment of inflammatory conditions like rheumatoid arthritis. The symptoms of some rheumatoid arthritis sufferers, for eg, Morning joint stiffness and pain, can be alleviated by fish oil supplements to some extent. But the evidence for beneficial effects for conditions such as asthma, psoriasis and Crohn's disease is far weaker (11). The omega-3 fatty acid / N-3 fatty acid regulates blood pressure, hematic clotting, glucose tolerance and nervous system development and functions (11). The omega-3 fatty acids are also called "Vitamin-F" from fatty acids (12) . EPA and DHA are found in cold water fishes, which possess a great quantity of body fat, but the content of EPA and DHA depends on climate, environment and the fish diet (13) . Other important marine sources of n-3 fatty acids include sea life such as frill, algae, microalgae and crustaceans.

The n-3 fatty acids can bring various benefits to athletes by attenuating the generation of oxidative stress and thus improving the muscular performance and immune function. They also play an important role in the body as formation of phospholipids. The DHA is found in higher levels in the retina, brain and sperm. The n-3 fatty acids alternated the loss of muscle strength and range of motion, blood markers of inflammation such as TNF-  $\alpha$  and markers of muscle damage, like myoglobin, creatine kinase and skeletal muscle slow troponin-I(14) . It also lowers skeletal muscle oxygen consumption during contractions, which provide fatigue resistance and improved contractile recovery in vivo (15).

### **Fatty acid diets**

The ALA is present in plant oils like flaxseed, soybean, canola oils and walnuts (16). DHA and EPA are present in fish and fish oils like krill oils, salmon, mackerel, tuna, herring and sardines (17). Beef from grass-fed cows has higher levels of omega-3s, mainly as ALA. DHA and other omega-3 fatty acids are seen in eggs, yoghurt, juices, milk and soy beverages (18). But the intake of omega-3 supplements (DHA) (EPA) can make bleeding more likely. Thus the patients having bleeding conditions and taking medicines like apixaban, betrixaban, clopidogrel etc., doctor's consultation is must before the intake of omega-3 supplements (19). Compared with no dietary intake of eicosapentaenoic acid and DHA, an intake of 5.5g of n-3 fatty acids per month was associated with a 50% reduction in the risk of primary cardiac arrest, after adjustment for potential confounding factors (20). The most abundant PUFA in most products is linoleic acids. Therefore, a typical, balanced indian diet will provide reasonable amounts of LA irrespective of the type of vegetable oils used. In

fact, the data used to compute the minimum amount of fat in the diet is required to prevent EFA deficiency is based on the assumption that the vegetable oil would contain only 20% of LA (21)

The dietary n-3 fatty acids are of two types, one is ALNA which is available in plant sources, especially in green leafy vegetables and in some vegetable oils. The other one is LC n-3 PUFA which is only present in marine fish and in certain types of seaweed. Thus ALNA is the predominant source of n-3 fatty acid, since the intake of marine fish in indian diet is very low except in specific coastal regions and therefore, the average intake of LC n-3 is negligible (22).

The increasing incidence of non-communicable diseases (NCDs) has been well documented and already 53% of deaths in India are due to NCDs, which can be due to low body mass index (BMI) (23). The number of extremely low body mass index (BMI) adults in India is one of the highest in the world. The low BMI is the sine qua non of the chronic energy deficiency, in which diets have low fat content. Thus, the intake of fatty acids is very essential (24).

#### **Docosahexaenoic acid (DHA)**

The docosahexaenoic acid (DHA) is one type of omega-3 fatty acid which has 22 carbon atoms. It is present in fishes like Tuna, Bluefish etc., (25). DHA plays an important role in secondary prevention of cardiovascular disease and anti-inflammatory properties (26). It is the structural component of the human brain, cerebral cortex and the skin (27). It is essential for proper fetal development and healthy aging (28). EPA and DHA are also the precursors for several metabolites that are potent lipid mediators, considered by many investigators to be beneficial in the prevention of treatment of several diseases (29). It can be challenging to get appropriate intake of EPA and DHA through diet alone, even though they are produced by water plants such as algae and are prevalent in marine animals. ALA is an important component of our diet as it is found in the many plants that are eaten, but it doesn't provide any health benefits with EPA and DHA. But it is possible to convert ALA to EPA and DHA by elongase and desaturase enzymes (30).

#### **Tissue membrane phospholipids**

The fatty acids have amphiphilic characteristics and act as barriers in membranes and thus protect the cell. The omega-3s fatty acids are the components of the phospholipids that form the structures of cell membranes (31). The individual omega-3s in the plasma or serum phospholipids is based on the percentage of total phospholipids fatty acids by weight (32). The fatty acids composition was measured for brain, heart, liver, skeletal muscles, erythrocytes, plasma phospholipids as well as adipose tissue and plasma triglycerides (33). The natural and synthetic fatty acids modify the physical properties of lipid membranes. The fatty acids are involved in the cell signalling process and in the pathological states of the cell. And the changes of the membrane lipid structure may revert the cell dysfunctions (34). The natural fatty acids are the constituents of more complex lipids like triglycerides or phospholipids, which are used by cells to store and obtain energy, as well as for structural properties. The natural and synthetic fatty acids may modify the structure of lipid membrane, altering its microdomain organization and other physical properties and provoking changes in cell signalling(35). Therefore, by modulating the fatty acids, it is possible to regulate the structure of the membrane, influencing the cell process that are reliant on this structure and potentially reverting pathological cell dysfunctions that may provoke cancer, diabetes, hypertension, Alzheimer's and Parkinson's disease (36).

#### **Atherosclerosis**

The omega-3 fatty acids decrease the level of triglycerides which affects the lipid-laden macrophages (Foam cells) that cause the atherosclerotic chronic inflammation (37). The dietary supplementation of omega-3 rich fish oil reduces the

occurrence of atherosclerosis due to increased EPA and DHA, in the aorta and in the heart, while the AA content is decreased (38).the fish oil supplementation prevents the rise of aortic levels of MMP-2 after the exposure to chronic intermittent hypoxia (39). The higher intake of dietary n-3 fatty acids decreases the serum levels of pro-inflammatory biomarkers, including Interleukin-6 (IL-6), soluble-E-selectin, ICAM-1, VCAM-1 and C-reactive protein (40).

It causes the leukocyte recruitment which is an important process which includes neutrophils, monocytes, and T-cells and to a lesser extent, B-cells, dendritic cells and mast cells. Changes of macrophage phenotypes have been observed during the development of atherosclerosis which can be regulated by n-3 fatty acids (41).

### **3. Coronary Heart disease (CHD)**

The omega-3 fatty acids reduce the level of plasma TGs which is a risk factor of CHD and exerts anti-arrhythmic effects ischemic and reduces blood pressure and the heart rate (42). The CHD is caused by the underlying atherosclerosis which is the accumulation of lipids (LDL) which leads to recruitment and activation of leukocytes in the vascular wall (43). The omega-3 fatty acids containing EPA and DHA are the protective factors and lead to decreased cardiovascular risk in populations with high marine food intake (44). To control the risk factors, dietary modifications have been recommended to reduce the prevalence of coronary heart disease.  $\Omega$ -3 FA, EPA and DHA of the fish oils can be beneficial for prevention of CHD. The effects can be ascribed to anti-inflammatory, vasodilating, antiarrhythmic, antihypertensive activities and lowering of triacylglycerol level. A recently published meta-analysis of 17 prospective cohort studies showed that eating fish once a week compared to eating less fish was associated with 16% lower risk of fatal CHD (45).

### **4. Cardiovascular effects of $\Omega$ -3 fatty acids**

Inverse relation of blood and tissues is caused by marine omega-3 fatty acids for the management of myocardial infarction(46). The higher dietary and plasma levels of omega-3s lowers the risk of heart failure, coronary disease and fatal CHD (47). The omega-3s protect from CVD by reducing the heart's susceptibility to arrhythmias by lowering triglyceride levels, blood pressure and platelet aggregation (48). Furthermore , n-3 PUFAs have been found to decrease submaximal and peak heart rate as well as body oxygen consumption during exercise, resting heart value variability, submaximal and resting heart rate, systemic vascular resistance and diastolic blood pressure (49). Compared with no dietary intake of EPA and DHA, an intake of 5.5g of n-3 fatty acids per month was associated with a 50% reduction in the risk of primary cardiac arrest, after adjustment for potential confounding factors (50). Compared with a RBC membrane n-3 PUFA of 3.3% of total fatty acids, a RBC n-3 PUFA level of 5.0% of total fatty acids was associated with a 70% reduction in the risk of primary cardiac arrest (20).

### **5. Inflammatory disease**

The omega-3 fatty acids have anti-inflammatory properties for the management of inflammatory and autoimmune diseases (51). The higher omega-3s intake causes reduced inflammation (52). The alternative treatment with fewer side effects which reduces inflammatory response is the intake of omega-3 EFA found in fish oils (51). The anti-inflammatory effects of fish oils are partly mediated by inhibiting the 5-lipoxygenase pathway in neutrophils and monocytes and inhibiting the leukotriene B4 mediated function of leukotriene B5. in addition, omega-3 decrease IL-1 and IL-6 inhibits inflammation (53). For eg., Rheumatoid arthritis has a strong inflammatory component, which is observed through increased IL-1. N-3 PUFAs reduce IL-1 as well as the number of swollen and tender joints. The N-3 FAs reduce oxidative,

inflammatory and vasogenic processes. In this regard, they were tested in several studies in order to display the reduction of the symptoms of atopic dermatitis, sunburn, aging and skin infections caused by *P.acnes* and *S.aureus* because of their antimicrobial and anti-inflammatory action (54).

## 6. Behavioural disorders

Omega-3 fatty acids from fish oils improve the borderline personality disorder, bipolar disorders, ADHD and improve mental skills (55). It reduces depression, antisocial and aggressive behavior problems in children (56). The higher fish intake of omega-3s lowers 17% risk of depression and reduces major depressive disorder in adults (57). People who consume omega-3s from foods such as fish lowers the risk of developing Alzheimer's disease, Dementia and other problems with cognitive functions. DHA appears to be important for the visual and neurological development of infants (58).

## 7. CONCLUSION

Many epidemiological studies had been conducted for health benefits of omega-3 FA. This review has summarized the structural features, properties, dietary sources, metabolism and bioavailability of omega-3 PUFAs. There are many health benefits of omega-3s, efficacy and certain benefits to human health. It also emphasizes the effects of omega fatty acids on CVD, diabetes, cancer and Alzheimer's disease. The omega fatty acids help in treating patients with dementia and depression. It helps in visual and neurological development and improvement of maternal and child health.

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