The role of Docosahexaenoic Acid (DHA) in cardiovascular health and sports nutrition

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ABSTRACT: The goal of sports nutrition is to optimise an athlete’s performance. Docosahexaenoic acid (DHA, 22:6n-3), an omega-3 long-chain polyunsaturated fatty acid, provides unique health benefits. DHA is found throughout the body. It is a major structural fat in the brain and retina and a key component of heart tissue. The benefits provided by an adequate consumption of DHA include improvements in cardiovascular health and brain and eye function. DHA is also associated with reduced inflammation, maintenance of lean body composition, and improved cognitive and visual performance. DHA may promote better athletic performance by optimising oxygen and nutrient delivery to tissues.

INTRODUCTION

The goal of sports nutrition is to utilise strategic eating and refuelling to optimise an athlete’s performance. All athletes depend on their cardiovascular system, eyesight, and brain function to enhance their performance. For optimal performance, intake of healthy foods and beverages that are enriched with essential nutrients and ingredients is important. One of the ways to ensure optimal nutrition, not only for athletes but for all individuals, is to include omega-3 long-chain polyunsaturated fatty acids (omega-3 LCPUFAs) in the diet. Omega-3 LCPUFAs are obtained primarily from marine mammals and fatty fish. Unfortunately, neither is common in a typical western diet [1]. One of the most important omega-3 LCPUFAs is docosahexaenoic acid (DHA). It is highly concentrated in several key locations throughout the human body: the grey matter of the brain, the retina of the eye, and the tissues of the heart [2]. Yet, despite its importance, most people, including athletes, seldom get enough DHA [1]. In this review, we describe the function of DHA and its impact on cardiovascular health as well as its potential role in sports nutrition. Today, more than ever, people are looking for a way to eat a healthier diet. Omega-3 LCPUFAs are gaining recognition in the scientific community as a healthy ingredient that confers benefits throughout life. There are three important omega-3 LCPUFAs: α-linolenic acid (ALA), eicosapentaenoic acid (EPA), and (DHA). Each provides distinct and often misunderstood health benefits. For the athlete and for the population as a whole, DHA plays an important role in nutrition by optimising cardiovascular health [3]. Although not the focus of this review, research shows that DHA plays a role in brain and eye function which are also important to athletic performance [2].

ALPHA-LINOLENIC ACID (ALA)

ALA is considered a parent or precursor fatty acid [4]. The primary function of ALA is CO₂ production that is used as fuel [4]. As a secondary function, ALA serves as a precursor to EPA and DHA production [4]. However, only a small amount of ALA (approximately 3-4 percent) is biochemically converted to EPA providing approximately 21 percent of the EPA level needed by the body [4]. An even smaller amount of ALA is converted to DHA (< 4 percent) and often undetectable in men [5]. It is a common misconception that canola and flaxseed oils, a source of ALA, are an adequate dietary source of EPA or DHA [4]. Because the conversion of ALA to EPA or DHA is minimal, canola and flaxseed (as well as other dietary sources of ALA) are not adequate sources of EPA or DHA.

EICOSAPENTAENOIC ACID (EPA)

EPA acts as a precursor for the prostaglandin-3 and thromboxane families [3]. A diet rich in EPA lowers serum lipid concentrations, reduces cardiovascular disease, and prevents platelet aggregation [6]. EPA is also thought to be effective in lowering inflammation [7]. The effect of EPA in lowering inflammation is associated with reduced production of pro-inflammatory eicosanoids from ALA, since EPA and ALA use the same enzymes for synthesis of eicosanoids [8]. Studies also indicate that EPA in combination with additional therapy may have a role in treating certain psychiatric disorders such as schizophrenia and clinical depression [9]. Additionally, supportive research shows that EPA in concert with DHA may reduce the risk of cardiovascular disease [3].

DOCOSAHEXAENOIC ACID (DHA)

DHA is a long chain 22-carbon polyunsaturated omega-3 fatty acid. It is found in cell membranes throughout the body and in all organs. Studies have shown that DHA (alone – without EPA) provides cardiovascular health benefits [6] as well as health benefits for the brain and eyes [2]. Unlike ALA and EPA, DHA accumulates readily in the tissues of the cardiovascular system, brain, and eyes. DHA represents up to 97 percent of the omega-3 fatty acids in the brain and up to 93 percent of the omega-3 fatty acids in the retina [10]. DHA is a long, fluid, flexible molecule which imparts its fluidity and flexibility to cell membranes. These characteristics are particularly important to rapid membrane functions such as synaptic transmission, in which information is transmitted between neurons in the brain. DHA also supports myelination (the protective coating on nerves) which influences the speed at which information is acquired and processed [11]. DHA incorporation into cell membranes affects the development of eicosanoids which are associated with sleep induction, spatial learning, and resolution of neuroinflammation [12, 13].

Dietary sources of DHA include fatty fish (i.e. herring, salmon and tuna) and organ meat. However, concerns over the...
levels of oceanic pollutants and toxins as well as the levels of cholesterol in organ meat are legitimate dietary concerns. Algal DHA is a vegetarian source of DHA that is free of contaminants and cholesterol yet provides all of the health benefits of DHA.

Dietary Recommendations

The European Commission asked the European research project Perlip (Influence on Dietary Fatty Acids on the Pathophysiology of Intrauterine Foetal Growth and Neonatal Development) to develop recommendations on dietary fat intake in pregnancy and lactation, based on current scientific findings (14). The adopted recommendations indicate that pregnant and lactating women should aim to consume an average dietary intake of at least 200 mg of DHA daily and noted that intakes of up to 1 g/day have been used in randomized clinical trials without significant effects (14). Supplements of up to 6 g of algal DHA per day have been considered in healthy individuals without any adverse events (15).

DHA and Cardiovascular Health

It is well established that DHA not only lowers triglyceride (TG) levels (16) but also provides other cardioprotective effects such as reduction in the risk of sudden death (17), decreased risk of certain arrhythmias (18), lower risk of atherosclerosis and ischemic heart disease (3), and reduced blood pressure (16). Clinical studies have also demonstrated the beneficial effects of a diet rich in omega-3 LCPUFAs or supplemented with omega-3 LCPUFAs on coronary morbidity in patients with coronary heart disease (19).

Early investigations into the favourable effects of omega-3 LCPUFAs from fish oil attributed the cardiovascular benefits to EPA, ignoring the presence of a substantial amount of DHA (20, 21). This was an understandable assumption as early studies typically used menhaden oil, the only fish oil product commercially available at the time. Since menhaden oil consists of more EPA than DHA (18 vs. 9.6 percent of total fatty acids), many researchers concluded that EPA rather than DHA delivered the benefits. The relative contribution of each omega-3 fatty acid to cardiovascular protection, including TG reduction, needed to be defined. Recent data demonstrate that both DHA and EPA individually have certain important cardioprotective properties (22). For example, EPA may not be as effective as DHA with respect to blood pressure reduction (23). Clinical trials with DHA from algae have demonstrated a marked and significant reduction in serum TG levels (up to 26 percent) in normal individuals and in those with hypertriglyceridemia or combined hyperlipidemia (22). This finding is important because elevated TG levels have been identified as a potential independent risk factor for cardiovascular disease (24). DHA also increases the good cholesterol sub fraction high-density lipoprotein cholesterol [HDL-C] and low-density lipoprotein cholesterol (LDL-C) particle size, a finding that may represent additional anti-atherogenic effects (3, 6, 12, 16, 22).

Other Health Benefits

Omega-3 LCPUFAs supplementation may also help reduce body fat, inflammation, and symptoms of arthritis (25). Hill et al. (25) reported that both fish oil supplementation of DHA+EPA and moderate exercise reduce cardiovascular risk and may counteract inflammation. Ott et al. (26) discuss the anti-inflammatory effects of omega-3 LCPUFAs, especially DHA for the prevention and treatment of neurological disorders. These investigators reported reductions in the production of proinflammatory cytokines and T lymphocyte proliferation and increases in adiponectin which can decrease inflammation. In a 2004 review, Covington (27) summarises the evidence that shows omega-3 LCPUFAs reduce the number of tender, swollen joints and morning stiffness in patients with rheumatoid arthritis.

The Potential Role of DHA in Sports Nutrition

DHA may influence sports performance by improving aerobic metabolic processes and the ability to use fat as an energy substrate (28). This is accomplished by enhancing delivery of oxygen and nutrients and removing waste products from tissues. Post-exercise recovery time may decrease due to reduced inflammation and increased release of growth hormones (29). Walser et al. (28) reported that stroke volume and cardiac output increased during exercise when DHA+EPA were administered to subjects. This finding suggests that DHA+EPA may increase oxygen delivery during exercise.

Other researchers have shown that DHA+EPA supplementation improves circulatory function through improved endothelium-dependent vasodilation (25, 28). Enhanced brachial artery blood flow and conductance during exercise are also observed, suggesting improved endurance performance (28). DHA supplementation decreases heart rate at rest and improves 1 minute heart rate recovery after exercise (30). Both of these DHA-related effects may contribute to better athletic performance and exercise recovery. Findings that demonstrate DHA supplementation during exercise positively affects cognition and the strength of the connection between synapses in the brain (29) are important and require further study.
CONCLUSIONS

DHA is a major structural fat found in the brain, retina, and heart tissue and provides health benefits for people of all ages. For athletes who are concerned with their performance, DHA promotes heart, eye, and brain health. Clinical studies have shown that DHA independently lowers TG levels, increases HDL-C levels, and improves blood vessel function. Further studies are needed to elucidate the many roles that DHA supplementation may play in sports nutrition and performance. Future research should also consider a variety of sports and athlete populations.

REFERENCES AND NOTES


Table 1. Benefits of DHA

<table>
<thead>
<tr>
<th>Cardiovascular Health Benefits</th>
<th>Potential Sports Nutrition Benefits</th>
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<tbody>
<tr>
<td>Improving dyslipidemia (reduced TG, increased HDL, and improved LDL particle sizes) (3, 12, 16, 22)</td>
<td>Improved circulatory function</td>
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<tr>
<td>Improving vascular function (improved arterial compliance, endothelial function, and endothelium-dependent arterial vasodilation) (3, 6, 28, 30)</td>
<td>Improved metabolic processes</td>
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<td>Lowering heart rate and blood pressure (12, 23, 30)</td>
<td>Improved brain function and recovery from injury</td>
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<td>Improving cognitive function (29)</td>
<td>Maintenance of a lean body composition</td>
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<tr>
<td>Providing anti-inflammatory, anti-thrombotic, and anti-arrhythmia effects (3, 12, 18, 36)</td>
<td>Better learning and memory</td>
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<td></td>
<td>Better mental health</td>
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<td></td>
<td>Potentially providing improved aerobic capacity, reduced post-exercise recovery time, improved body composition and energy supply, enhanced cognition and recovery from athletic brain injury, and improved visual acuity</td>
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