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Omega-3 Fatty Acids in Sport and Exercise Recovery?

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Introduction

Omega-3 fatty acids (*n*-3 PUFA) are a group of polyunsaturated fatty acids characterized biochemically by a double bond at the third carbon from the methyl end of the carbon chain. The long chain *n*-3 PUFA eicosapentaenoic acid (EPA) (figure 1) and docosahexaenoic acid (DHA) (figure 2) are essential components of anti-inflammatory pathways and are believed to be the most bioactive *n*-3 PUFA [1]. EPA and DHA are *n*-3 PUFA found in animal sources such as cold water fatty fish (e.g., tuna, salmon), fish oils and krill oil and more recently vegetarian options have been sourced from marine algae. The *n*-3 PUFA are essential fatty acids, meaning they must be consumed through dietary sources because the body cannot manufacture them. Many varieties of *n*-3 PUFA supplements also exist. Recently, *n*-3 PUFA have received considerable attention in the context of nutritional support for exercise recovery. This attention stems from a range of studies underpinning a potential role for *n*-3 PUFA in promoting the remodelling and repair of skeletal muscle, enhancing immune surveillance and improving cognitive function. The primary purpose of this commentary is to critically evaluate, in a context-specific manner, the role of *n*-3 PUFA in promoting sport and exercise recovery.

Skeletal Muscle Remodeling

A topic of recent interest concerns the role of *n*-3 PUFA in facilitating the remodelling of skeletal muscle proteins during exercise recovery. The stimulation of MPS forms a key component of the muscle remodelling process [2]. As such, there is current interest in the synergistic role of other nutrients alongside protein for increasing the utilization of ingested protein for stimulation of MPS during exercise recovery [3]. Proof-of-concept studies in young [4] and older [5] adults demonstrated that 8 weeks of fish oil-derived *n*-3 PUFA (1.86 g EPA and 1.50 g of DHA) supplementation increased MPS in response to the intravenous infusion of amino acids and insulin. The mechanism proposed to explain this priming action of *n*-3 PUFA in stimulating MPS involves the direct incorporation of *n*-3 PUFA into the muscle phospholipid membrane [4,6]. Accordingly, the incorporation of *n*-3 PUFA into the muscle cell membrane is associated with an increased expression of membrane-bound cell signaling proteins, including focal adhesion kinase (FAK), protein kinase B (PKB) and mechanistic target of rapamycin (mTORC1) [6]. Given that experiments in cell culture reveal that EPA, rather than DHA, is the active ingredient in terms of stimulating MPS [7], these proof-of-principle studies suggest a role for EPA-rich *n*-3 PUFA in facilitating muscle remodeling.

We recently conducted a physiologically relevant follow-up study in resistance-trained young males and demonstrated that 8 weeks of fish oil supplementation failed to modulate rates of MPS in response to feeding 30 g (≈0.35 g/kg) of whey protein following resistance-based exercise [8]. Thus, in the context of ingesting a protein dose known to stimulate a maximal response of MPS [9,10], we concluded that fish oil supplementation conferred no advantage in terms of facilitating skeletal muscle remodeling during exercise recovery in trained young males. Whereas these data apparently contradict results from the previously described proof-of-principle studies [4,5], future research is warranted to investigate the influence of *n*-3 PUFA supplementation on the response of MPS to ingesting a suboptimal protein dose, or whilst in severe energy deficit. These data may reveal a context-specific role for *n*-3 PUFA in facilitating skeletal muscle protein remodeling. Moreover, given that a rodent study reported an amelioration of muscle mass loss during limb immobilisation with fish oil supplementation [11], preliminary evidence substantiates a

rehabilitative/prehabilitative role for *n*-3 PUFA during catabolic situations such as injury-induced leg immobilisation that are common across various sporting activities.

Skeletal Muscle Repair

The role of *n*-3 PUFA also has been investigated in the context of soft tissue injuries caused by intense exercise. The anti-inflammatory properties of *n*-3 PUFA are proposed to ameliorate feelings of muscle soreness and impairments in muscle function associated with eccentric exercise [12]. Such eccentric-based muscle contractions are routinely performed in various sporting settings [13], particularly team-based sports. Some studies have shown a protective role for *n*-3 PUFA intake in attenuating muscle soreness [14,15] and oxidative stress [16] 2 days following exercise. These preliminary data suggest a role for *n*-3 PUFA in promoting skeletal muscle repair. Future studies with the purpose of investigating the protective role of *n*-3 PUFA during acute exercise recovery should be conducted in high performance athletes and include validated sport-specific performance measurements (*e.g.,* Loughborough passing test).

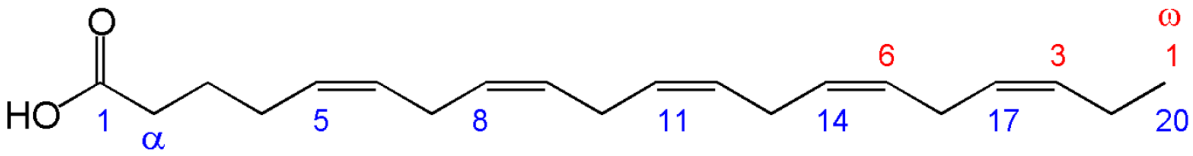

Figure 1: Chemical structure of eicosapentaenoic acid (EPA) Source: Wikipedia, Public Domain

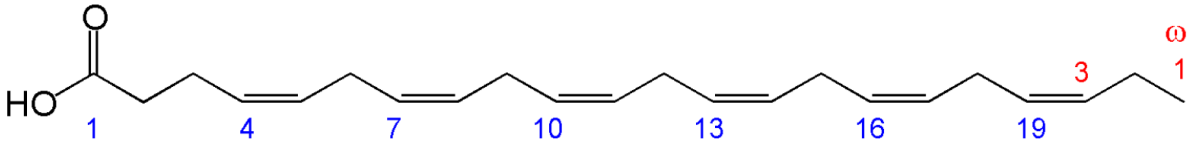

Figure 2: Chemical structure of docosahexaenoic acid (DHA) Source: Wikipedia, Public Domain

Immune Surveillance

The *n*-3 PUFA also exhibit immuno-modulatory properties. In addition to their anti-inflammatory properties, EPA and DHA also have been shown to alter neutrophil proliferation and monocyte phagocytosis [17]. Two recent studies implicate a role for *n*-3 PUFA in improving the immune status of recreationally-trained volunteers during exercise recovery [18,19]. Six weeks of fish oil supplementation (3 g/d, 1.3 g EPA and 0.3 g DHA) increased interleukin 2 production and the cytotoxic activity of natural killer cells during 3 hours of exercise recovery [19]. Consistent with these acute findings, a recent longitudinal study reported fewer symptoms of upper respiratory tract infection when volunteers received a fish-oil containing supplement during 16 weeks of training [18]. Taken together these preliminary results implicate a potential role of *n*-3 PUFA in improving immune status during intense exercise training.

Cognitive Function

DHA plays an essential role in the functioning of neural tissue, and thus may have implications for improving cognitive function [20] and protecting against traumatic brain injuries that lead to concussion [21]. When examining the structure of the phospholipid bilayer of neurons, DHA is the most prevalent *n*-3 PUFA and is also involved in the synthesis of neuroprotectins (antioxidant, antiapoptotic and anti-inflammatory molecules) [20]. The prevalence of DHA within neural tissues has been shown to impact cognitive performance, memory and learning ability in both animal [22,23] and human [24] studies. After 6 weeks of *n*-3 PUFA (4 g/d, 1.6 g EPA, 0.8 g DHA) supplementation, healthy young adults demonstrated improvements in cognitive test performance, faster reaction times and a prolonged attention span [24]. Interesting recent work also reported that DHA supplementation attenuated the severity of head traumas experienced by collegiate American Footballers over

the course of a season [25]. Taken together, these preliminary data support a potential role for *n*-3 PUFA in protecting against the incidence and severity of concussion associated with many team-based sports (e.g., American Football, Rugby League, Rugby Union and Soccer, etc).

Recommendations for Omega-3 Polyunsaturated Fatty Acid Intake

In general, the current research base provides promising evidence regarding a role for *n*-3 PUFA in promoting exercise recovery. As such, there is evidence linking *n*-3 PUFA ingestion with increased muscle repair and remodeling, reduced inflammation and improvements in immune status and cognitive function. However, based on current research it is not possible to quantify the minimally effective dose of *n*-3 PUFA to promote exercise recovery. The majority of studies cited in this commentary administered approximately 3 grams per day of *n*-3 PUFA. Future research may conceivably demonstrate lower doses of *n*-3 PUFA to be effective in promoting recovery. As a closing remark, caution should be employed when making a recommendation for *n*-3 PUFA intake given the potential side effect of *n*-3 PUFA intake on blood thinning [22]. Therefore, athletes and exercisers with a history of bleeding issues should consult with a physician before taking any doses of *n*-3 PUFA.

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