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Omega-3 Fatty Acids and Their Impact on Exercise-Induced Muscle Soreness and Inflammatory Response – A Literature Review

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Abstract

Introduction: Delayed onset muscle soreness (DOMS) commonly occurs after intense or unfamiliar exercise and is associated with muscle microdamage and inflammatory responses. DOMS may impair muscle function, physical performance, and adherence to rehabilitation or training programs. Due to their anti-inflammatory properties, particularly those of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), omega-3 fatty acids have been investigated as a potential intervention for reducing exercise-induced muscle soreness.

Purpose: This meta-analysis aimed to evaluate whether omega-3 fatty acid supplementation reduces the severity and duration of DOMS following exercise.

Materials and methods: A systematic search of PubMed and Google Scholar was conducted to identify peer-reviewed human studies involving exercise-induced DOMS, controlled omega-3 supplementation, and outcomes including perceived muscle soreness and inflammatory biomarkers.

Results: The findings were heterogeneous, although several studies reported modest benefits of omega-3 supplementation. Reduced muscle soreness and smaller increases in inflammatory markers, particularly creatine kinase and white blood cell count, were more frequently observed after longer supplementation periods. Results for CRP, TNF-α, and IL-6 were inconsistent, while short-term supplementation showed little or no significant effect on DOMS.

Conclusions: Omega-3 fatty acid supplementation may help reduce post-exercise muscle soreness and support recovery in some populations; however, variations in study design and supplementation protocols limit definitive conclusions. Further research is needed to determine optimal supplementation strategies and clarify the relationship between omega-3 intake, inflammation, and muscle recovery.

Keywords: omega-3 fatty acids, DOMS, inflammation

1. Introduction

Delayed Onset Muscle Soreness - DOMS - is a common experience for many who are physically active as well as those who undergo rehabilitation. Although it is a transient condition, it can affect athletic performance and adequate recovery without which one can be

prone to developing much more serious conditions [1]. Furthermore, for patients whose physical activity might be crucial to managing their illness, DOMS might cause problems with adherence to rehabilitation protocols. The management of DOMS is an important consideration for sports medicine as well as rehabilitation.

The underlying mechanisms of this process are complex and not fully understood, hence the need for more examinations of it. What is known from substantial amounts of research is that inflammation is a key factor in the development of DOMS [2]. Exercise produces micro tears in muscles and surrounding connective tissue [3]. The disruption of integrity of these morphological structures induces a cascade of inflammatory responses. This process, while necessary for tissue repair and adaptation, can lead to excessive soreness, swelling and impaired muscle function if happening within a prolonged period of time.

Modulating the inflammatory response in management of DOMS has been a subject of a number of studies due to those factors. Among factors reducing this process, omega 3-fatty acids have emerged as a plausible intervention. The most important ones to consider are eicosapentaenoic acids (EPAs) as well as docosahexaenoic acids DHAs which have been proven to influence signaling within immune cells through altering the composition of the membranes, reducing pro-inflammatory eicosanoids and promoting synthesis of pro-resolving mediators [4]. Through these mechanisms, omega-3 fatty acids might attenuate the post exercise inflammatory response, hence reducing the severity as well as the duration of DOMS.

Despite these possible links, the extents of these effects need to be further examined. The aim of this metaanalysis is to answer the question: Does omega-3 fatty acid supplementation reduce the severity and duration of delayed onset muscle soreness following exercise induced muscle damage?

2. Background

Omega-3 fatty acids are a group of polyunsaturated fatty acids which play an important role in human physiology - particularly inflammatory processes and cellular function. The fatty acids of particular interest include long-chain alpha-linolenic acid (ALA), EPA, and DHA. These compounds are obtained through dietary intake or metabolic processes. Dietary sources include oily fish such as albacore tuna, salmon, mackerel, sardines, herring as well as certain species of algae such as Schizochytrium spp., Crytthecodiniumcohnii and Phaeodactylumtricornutum [5, 6].

The metabolic processes involved in fatty acid synthesis include reactions of desaturation, elongation and β-oxidation. EPA is synthesized in the endoplasmic reticulum while DHA requires further processes which involve the peroxisome. The final stage of fatty acid metabolism takes place in

the peroxisome. These metabolic pathways are inefficient in humans which proves the need for their supplementation [5, 6].

European Food Safety Authority (EFSA) suggests a daily intake of 250 and 500 mg/day while higher doses of up to 5 g/day are considered safe for adults [7].

According to the National Academy of Medicine, adequate intake of omega-3 fatty acids depends on factors such as age and sex. Slightly higher intakes are suggested for males than for females [8].

3. Material and methods

A search for relevant peer-reviewed publications has been conducted examining the effects of omega-3 fatty acid supplementation on DOMS and inflammatory responses following exercise. Articles were found with the use of electronic databases - mainly PubMed as well as Google Scholar. These two sources were chosen due to their extensive coverage of a range of biomedical and sports science research. Search terms which have been inputted into the databases contained keywords such as “omega 3-fatty acids”, “EPA”, “DHA”, “DOMS”, “delayed onset muscle soreness”, “exercise induced muscle damage”, “inflammation”, “cytokines”, “eicosanoids”, “muscle recovery”. The functions of AND, OR were selected to identify the most relevant publications.

Selection Criteria

-Human participants: Studies done on human subjects were selected for applicability to patient populations.

-Exercise induced DOMS: Studies must have contained muscle soreness induced through a structured workout or at least one exercise

-Omega-3 fatty acid supplementation: Intervention in the studies must have included supplementation with omega 3-fatty acids - EPA and DHA were of particular interest.

-Measurable outcomes of DOMS and inflammatory responses: Studies must have reported at least one measurable outcome - particularly perceived muscle soreness, inflammatory biomarkers (ex. CRP, Il-6) or other indicators of muscle damage which could be quantified.

-Peer-reviewed publications were considered only

-Publications in English were considered only

Exclusion Criteria

-Studies on cell cultures or animals

-Did not include inflammatory response caused by exercise

-Did not include muscle damage caused by exercise

-Included dietary fatty acids instead of controlled supplementation of omega 3-fatty acids

Study Selection Explanation

The studies were chosen due to meeting the selection criteria in directly investigating the relationship between omega 3-fatty acid supplementation and DOMS. Studies which were designed with controlled

supplementation and measurable outcomes of muscle damage and inflammation have been chosen in particular.

Studies considered subjective outcomes (the subjects' pain and soreness assessed by themselves) as well as objective ones (inflammatory biomarker levels obtained from blood samples). Considering these two factors allows for comparing and contrasting findings across studies with varying dosage of supplementation, duration and participant characteristics.

4. Literature Review

Across the reviewed literature, omega-3-fatty acid supplementation showed mixed but promising effects on reducing muscle damage, inflammation and DOMS. Several studies showed a beneficial role, though results vary depending on duration of supplementation, dosage, training status and population. Some experimental studies suggest that omega-3 supplementation may reduce muscle soreness and improve recovery following intense or eccentric exercise. Jouris et al. (2011) reported a 15% lower muscle soreness in participants who consumed omega-3 fatty acids for two weeks prior to bicep curl exercises as opposed to the placebo group [9]. Similarly Makaje et al. (2024) found that overweight or obese men who consumed fish oil prior to HIIT cycling had lower creatine kinase (CK) level increases, no spike in white blood cells (WBC) counts and reduced muscle pain [10].

Short term supplementation was found to be less beneficial as shown in Lee et al. (2025) paper on acute supplementation of only 7 days prior to exercise. It observed only modest improvements in muscle recovery while none were observed in inflammatory markers (particularly tumor necrosis factor-α (TNF-α) was examined here) [11]. It supports the claim that omega-3 supplementation improves muscle recovery however the short term duration has no impact on inflammation.

When considering literature reviews such as Rittenhouse et al (2025) - it found no consistent reductions in common inflammatory markers such as C-reactive protein (CRP), TNF-α and interleukin-6 (IL-6). However several studies did include noteworthy reductions in DOMS and faster recovery [12]. Oxidative stress is consistently reduced with supplementation of omega-3 fatty acids. Specific fatty acids may play a role in these aspects as suggested by Heileson et al. (2024) as they found improvements in muscle recovery when EPA or DHA were administered individually [13], although the study could not conclude which one contributed to it more. Interestingly, combining the two in equal dosages seemed to reduce the effect as compared to individual separate dosing.

Not all research finds a correlation. Visconti et al (2021) found no correlation between high (6 and 8 g) omega-3 fatty acid supplementation for 30 days and recovery in resistance trained men [14]. Standley et al. (2010) also found no impact on DOMS, inflammatory markers or CK levels after 65 days of supplementation [15]. Loss et al. (2022) also observed no significant benefits in young women when supplementation occurred after exercise rather than beforehand [16].

Overall the literature suggests that omega-3 fatty acids may contribute to reduced muscle soreness and improved recovery in some populations, particularly untrained individuals or those undergoing intense exercise. However the findings on inflammatory markers are inconsistent and benefits are more limited in highly trained individuals or when supplementation occurs only after exercise. Differences in dosage, supplementation duration, training and study design likely contribute to the differences in findings.

Studies examining the relationship between omega-3 fatty acid supplementation and inflammatory processes during physical activity suggest a complex interaction between DOMS and immune responses. Intense physical exercise has been linked with increased chronic inflammation and oxidative stress, which may contribute to increased muscle weakness, fatigue and even muscle atrophy.

During physical exertion reactive oxygen species (ROS) are produced in elevated amounts. Excessive accumulations of these particles lead to tissue damage and inflammation through activating biological macromolecules [17]. EPA and DHA take part in promoting muscle remodeling, repairing via membrane incorporation, anti-inflammation and immune surveillance [6]. Characteristic features of inflammation are growth of markers such as IL-6, TNF-α, CRP and ROS. After physical activity the level of IL-6 increases. Omega-3 fatty acids can inhibit the activation of the NF-κβ pathway and the production of cytokines such as IL-6, IL-2, and IL-8 is reduced according to Fernández-Lázaro et al (2024) [18].

There are studies which indicate that omega-3 fatty acids may decrease inflammatory processes in muscle cells. In a study by Bloomer et al (2009) 15 men were supplemented with 2224 mg EPA+2208 mg DHA or a placebo for 6 weeks in a random order with an 8 week washout period. After 6 weeks of supplementation, both groups performed a 60-minute treadmill climb using a weighted pack. To assess oxidative stress and inflammatory biomarkers, blood samples were collected before and after exercise. It has been shown that men who received EPA and DHA had lower levels of CRP and TNF-α during rest, exercise as well as 30 minutes, 24 hours and 48 hours after exercise comparing to group with placebo [19]. This finding suggests that the supplementation may be helpful in individuals who begin sport exercises or perform longer activities that cause more inflammatory processes.

In another study by Okut et al (2025), a group of 15 males received omega-3 fatty acids for the duration of 8 weeks while another group of 15 males were control group and received no supplementation. Daily dosage of omega-3fatty acids was 3150 mg (including 1620 mg EPA and 1170 mg DHA). Both of groups performed resistance training three times per week. Blood samples were obtained and biochemical markers were analysed pre- and post-intervention. It has been found that CRP, IL-6 and TNF- α significantly decreases in experimental groups. Moreover there was a higher decrease in inflammatory markers in the group supplemented with EPA and DHA than in the control group. This indicates a possible anti-inflammatory effect of omega-3 fatty acids [20].

On the other hand, in a systematic review by Fernández-Lázaro et al (2024), which assessed the effect of EPA and DHA supplementation among other things, the results on inflammatory marker

changes were inconclusive. Among seven studies where IL-6 levels were assessed, only two showed a significant decrease following supplementation. CRP was significantly higher in the control group compared to the experimental group in just 2 of the 13 studies. Other inflammatory markers, such as TNF-α, was found to show no significant differences between groups [18].

The aforementioned studies show that omega-3 fatty acid supplementation (EPA/DHA) demonstrates anti-inflammatory effects with an immunomodulatory character. The studies reported reductions in pro-inflammatory cytokines, particularly TNF-α and IL-6, decreases in systemic inflammatory markers (e.g., CRP), attenuation of excessive inflammatory responses following exercise. It is important to note that omega-3 fatty acids do not completely suppress the inflammatory response but rather modulate its magnitude, limiting excessive pro-inflammatory cytokine production. This effect is relevant both for post-exercise recovery and for conditions characterized by chronic low-grade inflammation.

5. Discussion

This review offers several strengths, particularly in its breadth of included studies and critical evaluation of the literature. It benefits from the inclusion of studies published between 2009 and 2024, allowing for a comprehensive synthesis of both earlier and more recent research developments [9-20].

Our research has some limitations. It is difficult to determine whether long-term supplementation of omega-3 fatty acids brings benefits. The studies cited in our article lasted several weeks. On the other hand it can be concluded that short-term supplementation of omega-3 fatty acids does not cause decrease in inflammatory markers or improve muscle recovery. In addition, studied groups were very similar, mainly consisting of males. In one research where women were the focus group, no significant benefits of supplementation were shown [9-20].

Most of the relevant research indicates a reduction in muscle soreness and improved recovery after physical activity. Doses between 1200 mg and 4000 mg showed the best results when it came to lowering CK levels, reducing muscle pain and improving recovery. Larger doses, such as 6000 mg and 8000 mg of omega-3 fatty acids showed no significant effect on muscle recovery [9-16].

Another interesting finding is that the supplementation of EPA and DHA combined showed worse results on improving DOMS, than separate administration of either EPA or DHA. Most of the literature to date has either concluded that EPA and DHA have an effect or DOMS, however it has not been discerned which of the two has a more significant impact. Further investigations should be considered to assess the effects of administering either type of fatty acids as well as their combination [9-16].

In addition the exact duration of omega-3 fatty acid supplementation that brings benefits is unknown. Current research focuses on a maximum of several weeks of EPA and DHA supplementation. There are some studies which indicate that short-term (up to a week) and long-term (over 2 months) supplementation of omega-3 does not cause great improvement in muscle soreness and recovery. Further research should be conducted to determine whether supplementation with omega-3 fatty acids provides measurable benefits in pain reduction and accelerated muscle recovery over a limited period of time. In

particular, future studies should focus on clearly defined intervention durations and standardized dosing protocols in order to assess the short-term efficacy of omega-3 intake. It would also be valuable to examine the underlying physiological mechanisms, such as their potential anti-inflammatory effects and influence on muscle protein synthesis, which may contribute to improved recovery outcomes. Additionally, randomized controlled trials involving diverse populations and varying levels of physical activity could help establish the consistency and applicability of these effects to particular populations [9-20].

The studies were not clear in case of the effect of omega-3 fatty acids on inflammatory processes. However most of them indicate a significant decrease in CRP. Administration of EPA and DHA can decrease inflammatory processes when there is an increased ROS formation, inflammation, and muscle injury. Other inflammatory markers, such as IL-6 and TNF-α did not show significant decrease [18-20].

Overall, the studies reviewed here provide important insights into the impact of omega-3 fatty acids on the severity and duration of delayed onset muscle soreness, muscle recovery and inflammatory processes, while also revealing areas of uncertainty. These observations highlight the need for continued research and more rigorous study designs. The following section summarizes the key conclusions drawn from this review.

6. Conclusions

To conclude, this review has brought together findings from a range of studies to provide a comprehensive overview of the impact of omega-3 fatty acids on the severity and duration of delayed onset muscle soreness, muscle recovery and inflammatory processes. However, several gaps and inconsistencies remain that warrant further investigation. Addressing these limitations will be essential for advancing understanding in this field.

Taken together, the studies reviewed in this metaanalysis demonstrate that omega-3 fatty acids may decrease muscle soreness and improve muscle recovery. The effect on muscle soreness and recovery was more significant than the effect on inflammatory processes.

Further research should focus primarily on determining the dose of supplements taken that will be most beneficial in reducing muscle soreness and inflammatory processes. Another crucial point is assessment of the length of the therapy duration that brings benefits. More studies should be undertaken to evaluate the effects of omega-3 fatty acid supplementation in women. Furthermore, the results indicate that the effects of omega-3 fatty acid supplementation in women were not as beneficial as in men which warrant a possible intriguing lead for future research in the sex differences in this aspect.

Disclosure

Author's contribution

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