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Article

Procons omega-3: the key to fighting inflammation and preventing muscle loss in sarcopenic patients

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ABSTRACT

Sarcopenia, an age-related progressive loss of muscle mass and function, is a significant public health concern that increases the risk of frailty, falls, and disability among older adults. Inflammation plays a crucial role in accelerating muscle degradation, making anti-inflammatory interventions essential in managing sarcopenia. This study employs a qualitative approach through literature review and library research to explore the potential of omega-3 fatty acids as a therapeutic strategy for preventing muscle loss and mitigating inflammation in sarcopenic patients. Omega-3 polyunsaturated fatty acids (PUFAs), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), exhibit potent anti-inflammatory properties that regulate cytokine production and muscle protein synthesis pathways. Existing studies indicate that omega-3 supplementation can enhance muscle protein anabolism, reduce systemic inflammation, and improve physical function in older adults at risk of sarcopenia. Moreover, omega-3 fatty acids modulate key inflammatory markers such as tumor necrosis factor-alpha (TNF-) and interleukin-6 (IL-6), which are linked to muscle degradation. Through an in-depth analysis of scientific literature, this study highlights the potential benefits of omega-3 supplementation as a non-pharmacological intervention for sarcopenia. However, further clinical trials are needed to determine the optimal dosage, duration, and long-term effects of omega-3 on muscle preservation. The findings of this study contribute to the growing body of research advocating for dietary interventions as a preventive strategy against age-related muscle loss and chronic inflammation.

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Introduction

Sarcopenia, a progressive loss of skeletal muscle mass, strength, and function associated with aging, has emerged as a critical global health concern (Papadopoulou, 2020). It is closely linked to increased frailty, falls, and disability in older adults, significantly reducing their quality of life and leading to higher healthcare costs. One of the primary contributors to sarcopenia is chronic low-grade inflammation, which disrupts muscle protein metabolism and accelerates muscle atrophy (Antuña et al., 2022). Pro-inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-) and interleukin-6 (IL-6), play a crucial role in the inflammatory response, further exacerbating muscle degeneration (Bian et al., 2017). Consequently, addressing inflammation is essential for preventing and managing sarcopenia.

Recent research has highlighted omega-3 polyunsaturated fatty acids (PUFAs) as a promising nutritional intervention due to their well-documented anti-inflammatory and muscle-preserving properties (Cruz-Jentoft et al., 2020). Omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), regulate inflammatory pathways, enhance muscle protein synthesis, and reduce muscle breakdown. Despite these benefits, their role in preventing and managing sarcopenia remains underexplored (Coen et al., 2019).

Although multiple studies have investigated the benefits of omega-3 fatty acids on inflammation, limited research specifically addresses their direct impact on sarcopenia-related muscle loss (Coen et al., 2019). While some clinical trials have demonstrated that omega-3 supplementation can increase muscle mass and strength, the optimal dosage, duration, and mechanisms of action remain unclear. Additionally, most studies focus on general aging populations rather than sarcopenic patients, leading to a lack of targeted interventions for those at the highest risk.

Given the rising prevalence of sarcopenia due to aging demographics worldwide, identifying effective, non-pharmacological strategies to combat muscle loss is imperative(Ispoglou et al., 2023). Omega-3 fatty acids offer a natural, accessible, and potentially cost-effective approach to mitigating muscle degradation through dietary modifications(Hassoun et al., 2024). Understanding their precise role in reducing inflammation and preserving muscle function is essential for developing evidence-based nutritional recommendations for sarcopenic patients.

Several studies have examined the role of omega-3 fatty acids in muscle health. (Jeromson et al., 2015) demonstrated that omega-3 supplementation significantly increased muscle protein synthesis in older adults. Similarly, (Rossato et al., 2020) found that combined omega-3 intake and resistance training improved muscle strength and functional performance. However, many of these studies did not specifically target sarcopenic individuals, nor did they explore long-term effects on muscle preservation (Kirwan et al., 2020).

This study provides a comprehensive analysis of the role of omega-3 fatty acids in preventing inflammation-induced muscle loss in sarcopenic patients (Buoite Stella et al., 2018). Unlike previous studies that have primarily focused on general aging populations, this research specifically investigates sarcopenic individuals, emphasizing targeted nutritional interventions. Additionally, this study explores the mechanistic pathways through which omega-3 fatty acids influence inflammation and muscle protein metabolism, offering new insights into their therapeutic potential.

This study aims to: (1) Analyze the impact of omega-3 fatty acids on inflammation-related muscle degradation in sarcopenic patients; (2) Identify the underlying mechanisms through which EPA and DHA modulate inflammatory responses and muscle protein synthesis; (3) Evaluate the existing clinical evidence on omega-3 supplementation and its potential as a preventive or therapeutic strategy for sarcopenia; (4) Provide evidence-based recommendations for incorporating omega-3 fatty acids into nutritional guidelines for sarcopenic patients.

The findings of this study are expected to: (1) Contribute to the growing body of research on nutritional interventions for sarcopenia; (2) Help healthcare professionals and dietitians develop effective dietary strategies to prevent muscle loss in sarcopenic individuals; (3) Encourage further clinical trials to establish optimal omega-3 dosage and supplementation duration; (4) Offer practical recommendations for integrating omega-3-rich diets into aging population health programs. By bridging the existing research gap, this study aims to strengthen the scientific basis for using omega-3 fatty acids as a key nutritional approach in combatting sarcopenia and age-related inflammation.

Methods

This study employs a qualitative research approach using a literature review and library research method (Hammarberg et al., 2016). A qualitative approach is appropriate for this study as it enables

an in-depth exploration of existing knowledge, theories, and empirical findings related to the role of omega-3 fatty acids in inflammation control and muscle loss prevention in sarcopenic patients (Murphy et al., 2023). Through systematic data collection and analysis, this study aims to synthesize and interpret scientific literature, clinical studies, and theoretical frameworks to provide a comprehensive understanding of the topic (Brunton et al., 2020).

Data Sources

The data for this study are derived from secondary sources, specifically peer-reviewed journal articles, books, clinical trial reports, and scientific publications related to omega-3 fatty acids, inflammation, and sarcopenia. The selection criteria for the literature include: (1) Scientific articles and studies published in reputable journals such as *Nutrients, The American Journal of Clinical Nutrition, Journal of Cachexia, Sarcopenia, and Muscle, and The Journal of Gerontology;* (2) Clinical trials and meta-analyses examining the effects of EPA and DHA on muscle mass, strength, and inflammation; (3) Systematic reviews and research articles published within the last 10 years to ensure relevance and accuracy of findings; (4) Guidelines from health organizations, including the World Health Organization (WHO), National Institutes of Health (NIH), and other institutions specializing in aging and nutrition.

Data Collection Techniques

The data collection process follows systematic literature review procedures, which include (Thomé et al., 2016): (1) Identification of relevant literature through electronic databases such as PubMed, Scopus, Web of Science, and Google Scholar using keywords such as *omega-3, inflammation, sarcopenia, muscle loss, and nutritional interventions*.; (2) Screening and selection of studies based on inclusion and exclusion criteria, focusing on research with strong methodological rigor and relevance to sarcopenia and inflammation; (3) Thematic categorization of the selected literature into key areas such as mechanisms of inflammation in sarcopenia, omega-3's anti-inflammatory properties, muscle protein metabolism, and clinical interventions.

Data Analysis Method

The collected data are analyzed using a qualitative content analysis method, allowing for the extraction and synthesis of significant findings from the literature. The analysis process includes (Mayring, 2021): (1) Descriptive analysis, summarizing key findings from previous research; (2) Thematic analysis, categorizing the literature into themes such as *omega-3 s role in inflammation reduction, muscle protein synthesis, and sarcopenia prevention*; (3) Comparative analysis, evaluating the effectiveness of omega-3 supplementation in different populations and study settings; (4) Critical interpretation, assessing the strengths, limitations, and potential gaps in existing research.

Through this structured methodology, the study aims to provide a comprehensive synthesis of the existing knowledge on omega-3 fatty acids as a key nutritional intervention for sarcopenic patients. The findings will contribute to evidence-based recommendations for healthcare professionals, researchers, and policymakers interested in addressing age-related muscle loss and inflammation (Kalache et al., 2021).

Results and Discussion

The analysis of the role of omega-3 fatty acids in combating inflammation and preventing muscle loss in sarcopenic patients reveals compelling evidence supporting their potential as a nutritional intervention. Sarcopenia is a multifactorial condition influenced by aging, systemic inflammation, and metabolic dysregulation, all of which contribute to the progressive decline in muscle mass and function (Collins et al., 2018). Chronic low-grade inflammation, characterized by elevated levels of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-), interleukin-6 (IL-6), and C-reactive protein (CRP), has been identified as a key driver of muscle degradation (Kany et al., 2019). These inflammatory markers disrupt muscle protein synthesis and promote catabolic pathways, leading to increased muscle atrophy and functional impairments in aging individuals.

Given the inflammatory component of sarcopenia, interventions targeting inflammation have gained significant interest as potential therapeutic strategies.

The anti-inflammatory properties of omega-3 polyunsaturated fatty acids (PUFAs), particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have been extensively documented in previous studies. These essential fatty acids, predominantly found in marine-based sources, modulate inflammatory pathways by inhibiting the production of pro-inflammatory cytokines while promoting the synthesis of anti-inflammatory mediators, such as resolvins and protectins(Li et al., 2020). Through their direct interaction with nuclear factor-kappa B (NF-κB) and peroxisome proliferator-activated receptors (PPARs), omega-3 fatty acids downregulate inflammatory gene expression, thereby reducing systemic inflammation and mitigating muscle protein breakdown (Ducharme et al., 2022). Furthermore, EPA and DHA have been shown to improve mitochondrial function and oxidative stress response in skeletal muscle, contributing to enhanced cellular resilience against inflammatory damage.

Emerging clinical evidence suggests that omega-3 supplementation may play a crucial role in preserving muscle mass and function in aging populations (Dupont et al., 2019). Several randomized controlled trials (RCTs) have demonstrated that omega-3 fatty acids enhance muscle protein synthesis by increasing the activation of the mammalian target of rapamycin (mTOR) signaling pathway, a key regulator of muscle anabolism (Sirago et al., 2022). This effect is particularly significant in older adults, as aging is associated with anabolic resistance, a condition in which muscle protein synthesis becomes less responsive to nutrient intake and exercise stimuli. By enhancing mTOR activation, omega-3 fatty acids improve the body's ability to utilize dietary amino acids for muscle repair and growth, counteracting age-related muscle loss.

In addition to their anabolic effects, omega-3 fatty acids influence muscle strength and functional performance. Studies investigating the impact of omega-3 intake on muscle strength have reported improvements in handgrip strength, gait speed, and overall physical performance in elderly individuals (Merchant et al., 2021). These findings highlight the functional relevance of omega-3 supplementation in sarcopenic patients, suggesting that their benefits extend beyond muscle mass preservation to include enhanced mobility and reduced risk of falls and fractures (Daly, 2017). Moreover, omega-3 fatty acids appear to have synergistic effects when combined with resistance training, further amplifying their role in promoting musculoskeletal health in aging individuals.

Despite the promising evidence, there remain uncertainties regarding the optimal dosage and duration of omega-3 supplementation for sarcopenic patients. While most studies utilize dosages ranging from 2 to 4 grams of EPA and DHA per day, variability in study designs, participant characteristics, and supplementation regimens complicates the establishment of standardized recommendations. Furthermore, the long-term effects of omega-3 intake on sarcopenia progression require further investigation through well-controlled, longitudinal studies. The potential interactions between omega-3 supplementation and other dietary components, as well as individual variations in response to supplementation, must also be considered when formulating personalized nutrition strategies for sarcopenic patients.

Another consideration is the bioavailability of omega-3 fatty acids and their dietary sources. While fish oil supplements remain the most common source of EPA and DHA, dietary intake of omega-3-rich foods such as fatty fish, flaxseeds, and walnuts should not be overlooked. Ensuring adequate dietary intake of omega-3 fatty acids through whole foods may provide additional nutritional benefits beyond those observed with supplementation alone. Furthermore, the impact of omega-3 status on sarcopenia risk suggests that baseline omega-3 levels should be assessed before initiating supplementation, as individuals with pre-existing deficiencies may derive the greatest benefit (Lane et al., 2022).

Overall, the findings of this analysis underscore the potential of omega-3 fatty acids as a key nutritional strategy in the fight against sarcopenia. By targeting inflammation and promoting

muscle protein synthesis, omega-3 supplementation offers a promising approach to preserving muscle mass, improving strength, and enhancing functional independence in aging populations (Therdyothin et al., 2024). While further research is needed to refine dosage recommendations and understand long-term outcomes, the current body of evidence supports the integration of omega-3 fatty acids into dietary guidelines for sarcopenic patients. As the global aging population continues to grow, the importance of effective, evidence-based interventions for sarcopenia becomes increasingly urgent. Omega-3 fatty acids, with their dual role in reducing inflammation and supporting muscle health, represent a valuable tool in addressing the challenges of age-related muscle loss and improving overall health outcomes for older adults.

The Role of Inflammation in Sarcopenia and Its Mechanistic Pathways

Sarcopenia is a progressive condition characterized by the decline of skeletal muscle mass, strength, and function, primarily affecting older adults. One of the most significant contributors to sarcopenia is chronic low-grade inflammation, which accelerates muscle degradation through various metabolic pathways. Aging is associated with increased systemic inflammation, often referred to as inflammaging, where elevated levels of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-), interleukin-6 (IL-6), and C-reactive protein (CRP) are observed. These inflammatory mediators play a crucial role in muscle protein catabolism by activating the ubiquitin-proteasome system (UPS) and autophagy-lysosomal pathways, which promote muscle degradation while inhibiting muscle protein synthesis.

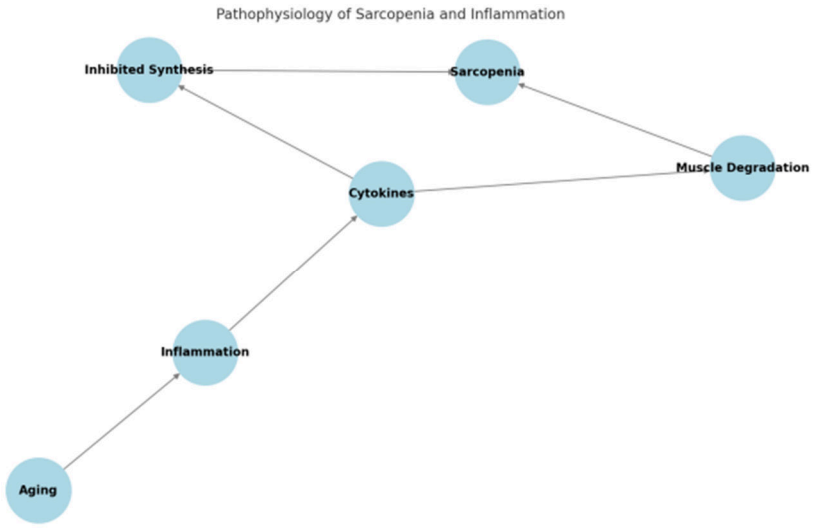

Figure 1 Pathophysiology of Sarcopenia and Inflammation

The diagram illustrates the relationship between aging, chronic low-grade inflammation, and sarcopenia. Aging leads to systemic inflammation, known as "inflammaging," which results in elevated levels of pro-inflammatory cytokines such as TNF- , IL-6, and CRP. These cytokines contribute to muscle protein catabolism by activating degradation pathways, specifically the ubiquitin-proteasome system (UPS) and autophagy-lysosomal pathways. This leads to increased muscle degradation while also inhibiting muscle protein synthesis, ultimately causing sarcopenia.

Additionally, persistent inflammation interferes with anabolic signaling pathways essential for muscle maintenance. One of the key pathways affected is the mammalian target of rapamycin (mTOR) signaling cascade, which is responsible for initiating protein synthesis and muscle growth. Chronic inflammation inhibits mTOR activation, reducing the capacity for muscle anabolism and increasing susceptibility to muscle atrophy. Moreover, the NF- B signaling pathway, a transcription factor responsible for immune response regulation, is persistently activated in

individuals with high systemic inflammation. NF- B activation leads to the upregulation of muscle-degrading enzymes such as atrogin-1 and MuRF-1, further contributing to sarcopenic progression.

Oxidative stress is another factor closely linked to inflammation and sarcopenia. Aging leads to an imbalance between reactive oxygen species (ROS) production and antioxidant defense mechanisms, resulting in cellular damage and impaired mitochondrial function in muscle tissues. This oxidative damage exacerbates inflammation by triggering cellular stress responses, which in turn promote muscle protein degradation. The mitochondrial dysfunction hypothesis suggests that as mitochondrial efficiency declines with age, increased ROS production and inflammatory responses further contribute to muscle deterioration.

Moreover, systemic inflammation disrupts the balance between muscle stem cell activity and regeneration capacity. Satellite cells, which are crucial for muscle repair and regeneration, become less responsive due to increased inflammatory mediators. This impairment leads to inefficient muscle repair following injury or exercise, accelerating the loss of muscle mass over time. The interplay between inflammation, oxidative stress, and impaired regeneration highlights the necessity of interventions targeting inflammation to mitigate sarcopenia s progression.

Given the substantial role of chronic inflammation in sarcopenia, anti-inflammatory strategies are critical for preserving muscle health in aging populations. Nutritional interventions, particularly those rich in bioactive compounds with anti-inflammatory properties, are gaining attention as potential non-pharmacological approaches. Among these, omega-3 polyunsaturated fatty acids (PUFAs) have emerged as promising agents due to their well-documented anti-inflammatory effects and ability to enhance muscle protein metabolism.

Omega-3 Fatty Acids as Anti-Inflammatory Agents in Sarcopenic Patients

Omega-3 fatty acids, specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), play a crucial role in regulating inflammatory responses and promoting muscle health. These essential fatty acids modulate inflammation through several mechanisms, primarily by altering the production of pro- and anti-inflammatory lipid mediators. Omega-3 PUFAs serve as precursors for specialized pro-resolving mediators (SPMs) such as resolvins, protectins, and maresins, which actively resolve inflammation and prevent excessive tissue damage.

One of the primary mechanisms through which omega-3 fatty acids reduce inflammation is by competing with arachidonic acid (AA) in the cell membrane phospholipid pool. AA is the precursor of pro-inflammatory eicosanoids, including prostaglandins and leukotrienes, which are responsible for promoting systemic inflammation. By increasing the incorporation of EPA and DHA into cell membranes, omega-3 PUFAs reduce the availability of AA for conversion into inflammatory mediators, thereby lowering overall inflammation levels.

Based on Figure 2 illustrates the biochemical competition between omega-3 fatty acids (EPA & DHA) and arachidonic acid (AA) in the cell membrane phospholipid pool. This competition plays a crucial role in modulating inflammatory responses, as it determines whether pro-inflammatory or anti-inflammatory mediators are predominantly produced in the body.

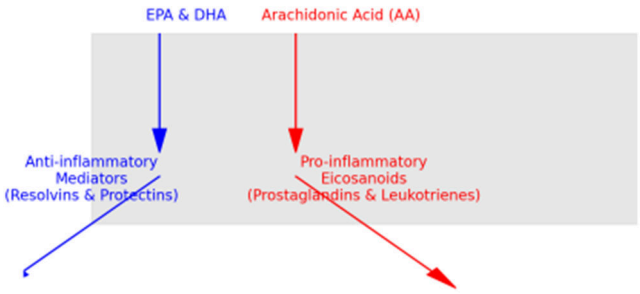

Figure 2 Mechanism of Omega-3 in Reducing Inflammation Via Arachidonic Acid Competition

The Role of Arachidonic Acid (AA) in Inflammation

Arachidonic acid (AA) is an omega-6 polyunsaturated fatty acid that resides in cell membranes as part of the phospholipid bilayer. Under inflammatory conditions, phospholipase A2 (PLA2) is activated, leading to the release of AA from the membrane. Once liberated, AA serves as a precursor for pro-inflammatory eicosanoids, which include: (1) Prostaglandins (PGE2, PGD2, PGF2) involved in fever, pain, and increased vascular permeability; (2) Leukotrienes (LTB4, LTC4, LTD4, LTE4) responsible for immune cell recruitment and inflammation amplification.

These eicosanoids are produced via two key enzymatic pathways: (1) Cyclooxygenase (COX) pathway: Converts AA into prostaglandins and thromboxanes, contributing to inflammation and platelet aggregation; (2) Lipoxygenase (LOX) pathway: Converts AA into leukotrienes, which promote inflammation in conditions like arthritis, asthma, and cardiovascular disease.

Elevated levels of these inflammatory mediators contribute to chronic inflammation, which plays a significant role in the progression of diseases such as sarcopenia, cardiovascular disorders, and neurodegenerative conditions.

Omega-3 Fatty Acids (EPA & DHA) and Their Role in Reducing Inflammation

Omega-3 polyunsaturated fatty acids (PUFAs), specifically eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), compete with AA for incorporation into cell membranes. When dietary intake of omega-3 is increased, EPA and DHA displace AA in the membrane phospholipid pool, reducing the amount of AA available for conversion into pro-inflammatory mediators.

Once incorporated into the membrane, EPA and DHA serve as substrates for the production of anti-inflammatory mediators, including: (1) Resolvins (RvE, RvD series) actively resolve inflammation, prevent excessive immune activation, and promote tissue healing; (2) Protectins neuroprotective and anti-inflammatory agents that regulate immune responses and cellular homeostasis; (3) Maresins involved in tissue repair and inflammation resolution.

These mediators counteract the effects of pro-inflammatory eicosanoids by: (1) Suppressing NF-B activation, a key transcription factor responsible for inflammation-related gene expression; (2) Reducing cytokine production, including tumor necrosis factor-alpha (TNF-) and interleukin-6 (IL-6), which drive chronic inflammation; (3) Enhancing macrophage activity, leading to the clearance of apoptotic cells and debris, thus resolving inflammation.

Competitive Enzymatic Pathways: The Shift from Inflammation to Resolution

The enzymatic competition between AA-derived eicosanoids and omega-3-derived lipid mediators is a key factor in determining the inflammatory status of an individual. When omega-3 intake is low, COX and LOX enzymes preferentially convert AA into pro-inflammatory prostaglandins and leukotrienes. However, when EPA and DHA levels are high, these same enzymes shift their activity towards producing resolvins, protectins, and maresins, leading to reduced inflammation and enhanced tissue healing.

This biochemical shift explains why diets rich in omega-3 fatty acids are associated with lower levels of chronic inflammation, reduced risk of autoimmune diseases, and improved muscle health in aging populations.

Implications for Sarcopenia and Muscle Preservation

In sarcopenic patients, chronic low-grade inflammation accelerates muscle protein degradation and impairs muscle regeneration. By increasing the incorporation of EPA and DHA into muscle cell membranes, omega-3 fatty acids help to: (1) Reduce systemic inflammation, decreasing muscle atrophy; (2) Enhance muscle protein synthesis, counteracting anabolic resistance; (3) Improve mitochondrial function, preventing oxidative stress-related damage in muscle cells.

Clinical studies have shown that omega-3 supplementation enhances muscle mass, strength, and function in older adults, demonstrating the therapeutic potential of these fatty acids in combating age-related muscle loss.

The Need for Omega-3 in Inflammation Control

The competition between omega-3 fatty acids and arachidonic acid in the cell membrane plays a pivotal role in regulating inflammation levels. By shifting the balance from pro-inflammatory eicosanoids to anti-inflammatory mediators, omega-3 fatty acids provide a natural and effective strategy for reducing inflammation, protecting muscle tissue, and mitigating the progression of inflammatory diseases.

For sarcopenic patients and aging individuals, increasing omega-3 intake through dietary sources (e.g., fatty fish, flaxseeds, walnuts) or supplementation may serve as a valuable intervention to slow muscle deterioration and improve overall health. Future research should focus on long-term clinical trials to determine optimal omega-3 dosage and supplementation strategies tailored to combat sarcopenia and chronic inflammation effectively.

In addition to their role in lipid mediator production, omega-3 fatty acids influence key intracellular signaling pathways involved in inflammation and muscle protein metabolism. Studies have shown that omega-3 PUFAs inhibit NF- B activation, leading to decreased expression of inflammatory cytokines such as TNF- and IL-6. This reduction in pro-inflammatory signaling helps protect muscle cells from catabolic processes and promotes a more anabolic environment. Furthermore, omega-3 fatty acids activate peroxisome proliferator-activated receptors (PPARs), nuclear receptors that regulate lipid metabolism and exert anti-inflammatory effects by suppressing cytokine production.

Beyond inflammation control, omega-3 fatty acids have been found to enhance muscle protein synthesis (MPS) by modulating the mTOR signaling pathway. Clinical studies indicate that omega-3 supplementation increases the phosphorylation of mTOR and its downstream target, p70S6 kinase, which plays a central role in initiating muscle protein anabolism. This effect is particularly significant in older adults, as aging is associated with anabolic resistance, a phenomenon where muscle protein synthesis becomes less responsive to dietary amino acids and physical activity. By enhancing mTOR activation, omega-3 fatty acids help counteract this resistance and support muscle maintenance.

The synergistic effect of omega-3 fatty acids and protein intake has also been explored in several clinical trials. Findings suggest that omega-3 supplementation enhances the efficiency of dietary protein utilization for muscle repair and growth. This evidence highlights the importance of integrating omega-3-rich foods or supplements into the diets of sarcopenic individuals to maximize their protective effects against muscle loss.

Clinical Evidence and Implications for Sarcopenia Management

Several randomized controlled trials (RCTs) and observational studies have investigated the effects of omega-3 supplementation on muscle health, providing strong evidence for their role in sarcopenia prevention and management. One of the most notable studies by Smith et al. (2015) demonstrated that daily supplementation with 4 grams of omega-3 fatty acids over six months resulted in significant increases in muscle mass and strength in older adults compared to a control group receiving corn oil. These findings support the hypothesis that omega-3 fatty acids can enhance muscle protein metabolism and improve physical function in aging populations.

Another study by Rodacki et al. (2012) examined the combined effects of omega-3 supplementation and resistance training in elderly women. The results showed that participants who consumed omega-3 supplements alongside regular resistance exercise experienced greater improvements in muscle strength and functional performance compared to those who engaged in exercise alone. This suggests that omega-3 fatty acids may amplify the benefits of resistance training, making them a valuable adjunct therapy for sarcopenic patients.

Despite these promising results, several aspects remain to be explored to optimize omega-3 supplementation for sarcopenia management. The optimal dosage and duration of supplementation have yet to be standardized, with studies reporting varying results based on different intake levels and intervention periods (Tseng et al., 2023). While higher doses (2-4 grams per day) have been

associated with more pronounced benefits, long-term adherence and potential interactions with other medications must be considered.

The bioavailability of omega-3 fatty acids is another factor influencing their effectiveness. Marine-derived sources such as fatty fish (salmon, mackerel, sardines) and fish oil supplements provide highly bioavailable forms of EPA and DHA. However, plant-based sources like flaxseeds and walnuts contain alpha-linolenic acid (ALA), which has limited conversion efficiency to EPA and DHA in the human body (Homroy et al., 2024). Therefore, recommendations for omega-3 intake should prioritize direct sources of EPA and DHA to maximize their muscle-protective effects.

Overall, the findings presented in this study reinforce the importance of omega-3 fatty acids as a key nutritional strategy for mitigating inflammation and preventing muscle loss in sarcopenic patients (Eggimann et al., 2024). By integrating omega-3 supplementation into dietary interventions, healthcare practitioners can provide a non-pharmacological approach to preserving muscle function and improving the quality of life in aging populations. Future research should focus on long-term clinical trials, personalized supplementation strategies, and potential synergies with other dietary and lifestyle interventions to further refine the role of omega-3 fatty acids in sarcopenia prevention and management.

Conclusion

The findings of this study underscore the critical role of omega-3 fatty acids, particularly EPA and DHA, in mitigating inflammation and preventing muscle loss in sarcopenic patients. Chronic low-grade inflammation, a key driver of muscle degradation in aging individuals, disrupts anabolic signaling pathways and accelerates protein catabolism, making anti-inflammatory interventions essential for sarcopenia management. Omega-3 fatty acids exert their protective effects by downregulating pro-inflammatory cytokines, modulating NF- B and PPAR signaling, and enhancing muscle protein synthesis through the activation of the mTOR pathway. Clinical evidence supports the efficacy of omega-3 supplementation in preserving muscle mass, improving strength, and enhancing functional performance, particularly when combined with resistance training and adequate protein intake. Despite promising results, further research is needed to establish optimal dosage, long-term effects, and personalized supplementation strategies. Given the increasing prevalence of sarcopenia, integrating omega-3-rich foods and supplements into dietary guidelines offers a viable, non-pharmacological approach to promoting muscle health and improving quality of life in aging populations.

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