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Jinal Parmar
Head, Clinical Dietician, Kiran Multi Super Speciality Hospital and Research Center, Surat, Gujarat, India

Payal Thakkar
Senior Clinical Dietician, Kiran Multi Super Speciality Hospital and Research Center, Surat, Gujarat, India

Sneha Thakur
M.Sc., Department of Dietetics and Applied Nutrition, Amity University, Kolkata, W.B., India

Jyothsna Devi Kuchipudi
Assistant Professor, Department of Nutrition and Dietetics, School of Allied Healthcare and Sciences, Jain Deemed to be University, Bangalore, Karnataka India

Correspondence
Jyothsna Devi Kuchipudi
Assistant Professor, Department of Nutrition and Dietetics, School of Allied Healthcare and Sciences, Jain Deemed to be University, Bangalore, Karnataka India

Therapeutic and nutritional potential of fish liver oil: A comprehensive review

Jinal Parmar, Payal Thakkar, Sneha Thakur and Jyothsna Devi Kuchipudi

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Abstract
Omega-3 fatty acids, vitamins A and D, and bioactive substances that support general health and disease prevention are among the many vital nutrients found in abundance in fish liver oil. Omega-3 fatty acids' anti-inflammatory and cardioprotective qualities assist lower blood pressure, enhance lipid profiles, and minimise the risk of cardiovascular illnesses. Vitamin A supports vision, immune function, and skin health, while vitamin D plays a crucial role in bone mineralization and calcium homeostasis. Additionally, fish liver oil has shown potential in enhancing cognitive function, alleviating symptoms of arthritis, and promoting overall well-being. An overview of the scientific evidence supporting the health benefits of fish liver oil is provided in this review, with a focus on its role in nutrition and preventive healthcare. Though it has many health benefits, excessive consumption can cause hypervitaminosis A and other negative effects, which emphasises the need for appropriate dosage recommendations.

Keywords: Fish liver oil, human health, omega-3 fatty acids, vitamin A and D, arthritis, cardiovascular health

1. Introduction
A rich source of vital nutrients, such as omega-3 fatty acids (EPA and DHA), fat-soluble vitamins A and D, and bioactive compounds that support general health, fish liver oil is mainly made from the livers of cod, halibut, and other fish species (Tewari *et al*., 2022; Turchini *et al*., 2009) [19, 20]. Numerous health advantages, including better cardiovascular health, increased cognitive function, less inflammation, and a stronger immunological response, have been associated with regular ingestion of fish liver oil (Ellulu *et al*., 2015) [6]. Vitamin D is essential for bone metabolism and immunological modulation, whereas vitamin A's high concentration promotes skin and visual health (Huang *et al*., 2018) [9]. Furthermore, it helps treat autoimmune diseases and arthritis because of its anti-inflammatory qualities (Li *et al*., 2017) [13]. An overview of the main health advantages of fish liver oil is given in this article, with special attention to the oil's therapeutic potential, function in preventing disease, and general well-being. Fish liver oil is a powerful source of critical fatty acids and fat-soluble vitamins that is derived from the liver of fish, mainly cod (Calder, 2017) [3]. It has been used traditionally as a dietary supplement to prevent and treat various ailments, particularly vitamin deficiencies and inflammatory conditions.

2. Nutritional Composition Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are essential for preserving cellular processes and general health, are abundant in fish liver oil (Ochi and Tsuchiya, 2018) [16]. Additionally, it is a great source of vitamins A and D, which support healthy bones and a strong immune system (Gogus & Smith, 2010) [8].

Table 1: Table summarizing the nutritional composition of various fish liver oils, compiled from published studies

Nutrient	Cod Liver Oil (%)	Shark Liver Oil (%)	Halibut Liver Oil (%)	Tuna Liver Oil (%)
Omega-3 (EPA+DHA)	20%	12%	15%	18%
Vitamin A	8%	25%	10%	5%
Vitamin D	15%	18%	20%	12%
Saturated Fat	30%	28%	32%	35%
Monounsaturated Fat	15%	10%	13%	18%
Polyunsaturated Fat	12%	7%	10%	12%

(Turchini et al., 2009) [20].

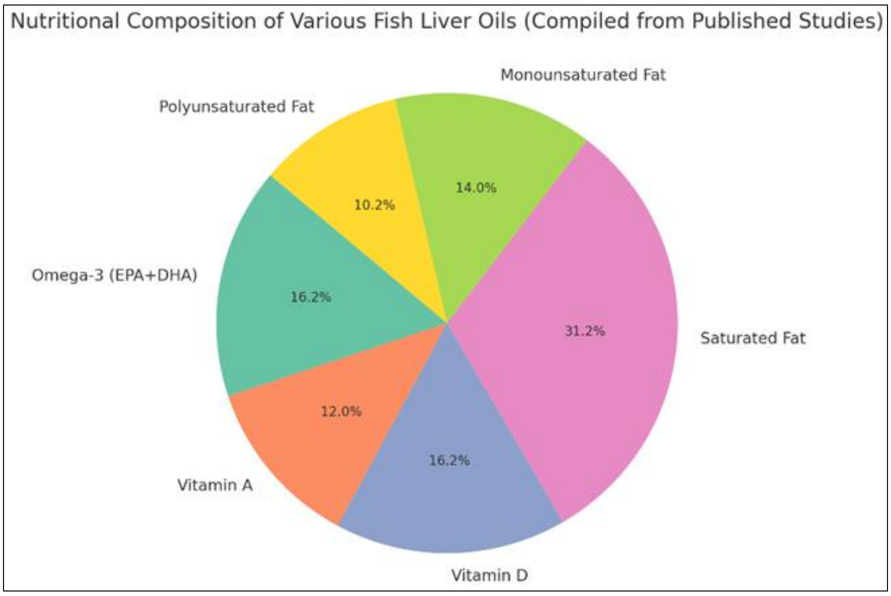

Fig 1: Nutritional composition of various fish liver oil

3. Health Benefits

3.1 Cardiovascular Health: The cardioprotective benefits of fish liver oil have been shown in numerous research (Goel *et al*., 2018) [7]. According to Mozaffarian and Wu (2011), omega-3 fatty acids can lower blood pressure, triglyceride levels, and the risk of arrhythmias. Furthermore, increased heart health and a lower risk of cardiovascular disorders are linked to vitamin D in cod liver oil (Kris-Etherton *et al*., 2003) [12].

3.2 Immune System Support: Because it strengthens mucosal barriers and increases white blood cell activity, vitamin A is essential for immune system maintenance (Semba, 2012) [17]. Additionally, vitamin D regulates the immune system and has been connected to a decreased risk of autoimmune diseases and infections (Martineau *et al*., 2017) [14].

3.3 Anti-Inflammatory Properties: Because of its high EPA and DHA content, fish liver oil has been shown to decrease inflammation (Ellulu *et al*., 2015) [6]. These omega-3 fatty acids have demonstrated promise in the treatment of inflammatory bowel illness and rheumatoid arthritis by inhibiting pro-inflammatory cytokines (Calder, 2017) [3].

3.4 Cognitive Function and Mental Health: DHA is necessary for cognitive function and is an important part of brain cell membranes. Supplementing with cod liver oil may reduce the risk of neurodegenerative disorders like Alzheimer's and alleviate anxiety and depression symptoms, according to studies (Kidd, 2007) [11].

4. Potential Risks and Considerations: Although cod liver oil has many health advantages, consuming too much of it can cause hypervitaminosis A and D, which can cause toxicity symptoms such nausea, lightheadedness, and liver damage (Bjelakovic *et al*., 2007). Furthermore, choosing high-quality supplements is crucial due to possible impurities including polychlorinated biphenyls (PCBs) and heavy metals.

Table 2: Summarizing the health benefits of fish liver oil, along with references from published studies

Health Benefit	Description	Reference
Cardiovascular Health	Fish liver oil, rich in omega-3 fatty acids, has been shown to reduce triglyceride levels, balance blood lipids, and improve overall heart health.	Kris-Etherton *et al.* (2003) [12]
Inflammation Reduction	The anti-inflammatory properties of fish oil can help reduce inflammation, which is beneficial for conditions like arthritis and may aid in muscle recovery for athletes.	D'Angelo *et al.* (2020) [5]
Bone Health	High levels of vitamin D in fish liver oil support bone health by aiding calcium absorption, potentially improving bone mineral density.	Charoenngam *et al.* (2019) [4]
Mental Health	Omega-3 fatty acids in fish oil have been linked to improved mental health outcomes, potentially reducing symptoms of depression and anxiety.	Su *et al.* (2018) [18]
Liver Health	Fish oil supplementation has been associated with improvements in liver enzyme levels and lipid profiles in individuals with metabolic dysfunction-associated steatotic liver disease.	Zhou *et al.* (2025) [21]
Skin Health	The nutrients in fish oil, including omega-3s and vitamins A and D, contribute to healthier skin by maintaining moisture and potentially alleviating conditions like dermatitis.	Ahmad *et al.* (2024) [1]
Longevity	Higher levels of omega-3 fatty acids have been associated with increased life expectancy, potentially adding years to one's life.	Karr *et al.* (2011) [10]

Because of its high content of omega-3 fatty acids (EPA and DHA), vitamins A and D, and other bioactive substances, fish liver oil is well known for its many health advantages. Studies have demonstrated that cod liver oil has numerous cardiovascular advantages, including the ability to lower triglyceride levels, control blood cholesterol levels, and promote general heart health (Kris-Etherton *et al*., 2003) [12]. These benefits are explained by omega-3 fatty acids' ability to improve endothelial function and reduce inflammation, both of which diminish the risk of cardiovascular illnesses like atherosclerosis and hypertension.

Another important health benefit of fish liver oil is its anti-inflammatory qualities. Fish liver oil is a useful supplement for treating chronic inflammatory diseases like arthritis since EPA and DHA have been demonstrated to modify inflammatory pathways by preventing the synthesis of pro-inflammatory cytokines (D'Angelo *et al*., 2020) [5]. This characteristic is especially helpful for athletes because it speeds up muscle recovery and lowers inflammation brought on by activity.

Because of its high vitamin D content, fish liver oil also has a significant impact on bone health. In order to preserve bone mineral density and avoid conditions like osteoporosis, vitamin D improves calcium absorption (Charoenngam *et al*., 2019) [4]. For those at risk for bone-related disorders, including as postmenopausal women and the elderly, regular supplementation may be especially helpful.

Omega-3 fatty acids may improve cognitive performance and lessen the symptoms of anxiety and sadness, according to studies on the effects of fish liver oil on mental health (Su *et al*., 2018) [18]. As a significant constituent of brain cell membranes, DHA is essential for neurotransmission and neuroprotection, both of which may lower the risk of neurodegenerative diseases like Alzheimer's.

Supplementing with fish liver oil also improves liver health. According to studies, omega-3 fatty acids enhance lipid profiles and liver enzyme levels, suggesting that they could be used as a treatment for steatotic liver disease (MASLD) linked to metabolic dysfunction (Zhou *et al*., 2025) [21]. By lowering hepatic inflammation and cholesterol buildup, omega-3 fatty acids' hepatoprotective properties may aid in the treatment of diseases such fatty liver disease.

Furthermore, omega-3 fatty acids and vitamins A and D found in fish liver oil support healthy skin by hydrating the skin, lowering inflammation, and perhaps curing diseases like dermatitis (Ahmad *et al*., 2024) [1]. These nutrients promote general dermatological health by supporting the function of the skin barrier.

Lastly, the anti-inflammatory and cardioprotective qualities of cod liver oil have been connected to its longevity advantages. Due to their potential to lower the risk of chronic diseases and oxidative stress, higher levels of omega-3 fatty acids have been linked to longer life expectancies (Karr *et al*., 2011) [10].

All things considered; fish liver oil's numerous health advantages underscore its significance as a functional supplement. Although its nutritional benefits are well established, careful dosage monitoring is required because to the possible hazards of excessive ingestion, including hypervitaminosis A and D. In order to maximise health benefits and minimise environmental effect, future research should concentrate on assuring sustainable manufacturing and optimising its bioavailability.

5. Conclusion

Rich in fat-soluble vitamins (A and D), important omega-3 fatty acids (EPA and DHA), and other bioactive substances that support general health and illness prevention, fish liver oil is a very valuable nutritional supplement. Frequent consumption has been linked to decreased inflammation, increased immunity, improved cognitive function, and better cardiovascular health. Its high vitamin A and D content also promotes skin integrity, eye health, and bone health. Although it has many advantages, too much of it might cause hypervitaminosis, therefore consumption must be monitored. Future studies should look on maximising its sustainability and bioavailability to reduce environmental issues and maximise health advantages.

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