Review Article

The importance of Omega-3 fatty acids in fish on human health

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Abstract

Heart failure (HF) incidence increases worldwide and is affected by various risk factors such as coronary artery disease, hypertension, obesity, and diabetes. Dietary recommendations for patients with HF have generally focused on sodium restriction; however, different nutritional approaches are considered in patients with a high risk of malnutrition due to the diuretic drugs they use. Omega-3 fatty acids obtained from aquatic organisms are essential regulators of cardiovascular health. There are different opinions on giving/consuming omega-3 fatty acids (and supplements) to improve the symptoms of heart failure. Although found mainly in oily fish, EPA and DHA, the marine n-3 polyunsaturated fatty acids are now found in commercially available supplements over the counter (as fish oils) or as concentrated pharmaceutical preparations. Fatty fish is the premier natural food source of EPA and DHA. In this study, we review the effects of omega-3 fatty acids, associated with low cardiovascular disease risk, on HF while trying to understand if it could ameliorate or exacerbate HF.

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Introductıon

Natural nutrition influences health and immune responses of humans. Fish is an essential nutrient in the human diet and is also present in consumers' global aquatic product industry. Aquatic products are the term of the aquatic animal and plant products and their processed products produced by marine and freshwater fisheries. Fish and fishery products have been identified as nutritional sources because of their high protein content. Nowadays, there has been much debate about the potential role of dietary supplementation with omega-3 fatty acids in preventing cardiovascular diseases (Selamoglu 2018a; Selamoglu 2018b; Selamoglu, 2021).

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Heart failure

Heart failure (HF), a common and severe public health problem accounting for substantial morbidity and mortality, is a systemic disease caused by complex neurohormonal, biochemical, and inflammatory systems. Its prevalence is increasing because of the aging of the population. Moreover, it is estimated that the majority of heart failure will increase by 25% in the next 20 years due to population aging (Franco *et al*., 2017; Metra and Teerlink 2017; Özaltun and Sevindik, 2020; Sevindik *et al*., 2021).

Recently, 26 million patients worldwide have HF, with more than 1 million hospitalizations annually in the United States and Europe, which account for 1% to 2% of total healthcare expenditures. HAPPY (Heart failure prevalence and predictors of in Turkey) study was conducted to determine the prevalence of heart failure in Turkey. According to this study, the absolute and estimated majorities were 2.9% and 6.9% for HF. Advanced age, male gender, history of heart disease are independent predictors of HF (Değertekin *et al*., 2012; Block *et al.*, 2019; Sevindik *et al.,* 2021).

Omega-3 fatty acids

Omega-3 (n-3) fatty acids are polyunsaturated fatty acids. Eicosapentaenoic acid (EPA; 20:5n-3), and docosahexaenoic acid (DHA; 22:6n-3) appear to be functionally the most important ones. The EPA and DHA are often referred to as marine n-3 fatty acids due to their association with seafood. Although the best dietary source of EPA and DHA is seafood, especially oily fish, they are now found in commercially available supplements over the counter (as fish oils) or as concentrated pharmaceutical preparations. Various commercial supplements such as fish oils, cod liver oil, krill oil, and some algal oils contain EPA and DHA. Concentrated pharmaceutical- grade preparations are available that contain EPA and DHA or contain only EPA (Saravanan *et al*., 2020).

The use of supplements is on the rise due to the several health benefits attributed to them. Significant benefits are reported concerning cardiovascular system diseases. Much research has been conducted during the past three decades to determine the appropriate dose needed to achieve a beneficial reduction in cardiovascular events. Although guidelines recommend using these agents in some cardiac disorders, there is still no clarity about fundamental issues, such as the appropriate dosage required. In addition, while there are doubts about some established benefits and assumed mechanisms of action, new uses and agencies are being identified (Saravanan *et al*., 2010).

Fatty fish is the premier natural food source of EPA and DHA. The beneficial role of n-3 PUFAs on blood lipids, cardiac electro-physiology, endothelial function, and blood pressure has been known. Still, polychlorinated biphenyls (PCBs), dioxin-like compounds (DL-Cs), and methylmercury (MeHg) in fish are identified as the most critical contaminants bioaccumulating and are classified as carcinogenic. PCBs are thought to play a role in developing cardiovascular disease (CVD) and its risk factors, such as hypertension, obesity, and

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diabetes. DL-C biomarkers, including dioxin-like PCBs, were related to higher mortality rates in the US populations. However, any potential confounding regarding a healthy diet, fish consumption, or EPA-DHA intakes was not measured. MeHg, which was not associated with CVD in a large US population, was associated after adjustment for EPA-DHA in a Nordic population (Donat- Vargas *et al*., 2019).

Omega-3 fatty acids and heart failure

Our daily food consumption plays a critical role in supplying energy needs, survival, and proper functioning of body organs. There has been much debate about the potential role of dietary supplementation with omega-3 fatty acids in preventing CVD in recent years. The beneficial effects of fish consumption on the cardiovascular system have mainly been attributed to the n-3 fatty acids, EPA, and DHA found in oily fish. British physiologist Sinclair was the first to assume that n-3 consumption could play a protective role in developing coronary heart disease (CHD). He demonstrated this protective role in the Greenland Inuits studies who have a higher consumption of fish oil in lowering CVD., which supports. Further, many researchers conducted pioneering studies among Greenland Eskimos and suggested that high intakes of EPA and DHA can be protective against CHD. A large 13-year observational study involving 60,000 participants reported a reduction in death attributable to heart failure with increased fish intake. Robert and his friends demonstrated that dietary n-3s consumption at supraphysiological levels preserves left ventricular function. It has been shown to prevent interstitial fibrosis in an overpressure-induced HF mouse model, as well. A dietary follow-up study designed to achieve omega 3 levels closer to those achieved in patients treated with high-dose prescription omega-3 acid ethyl esters demonstrated that only EPA exhibited protective effects. The Atherosclerosis Risk in Communities (ARIC), a prospective study of 3592 white men and women, reported that serum concentrations of n-3 PUFAs, especially docosahexaenoic acid, were associated with a lowered incidence of heart failure in women at 2-year follow-up HF (Wallin *et al*., 2012; Block *et al*., 2019; Punia *et al*., 2019).

Numerous observational and interventional studies have been conducted to assess the risks and benefits of fish consumption so far. According to three prospective epidemiological studies within populations, reviewed by Stone, reported that men who ate at least an amount of fish per week had a lower CHD mortality rate than men who did not eat at all. A large randomized trial reported significant reductions in overall mortality and hospitalizations in New York Heart Association class II-IV heart failure patients given 1 g of EPA and DHA per day. Despite the observed benefit being average, the benefits seen with the use of n-3 PUFAs in heart failure management. The American Heart Association recommended consuming non-fried fish, especially species with higher n-3 PUFAs, 1 to 2 servings per week for positive heart health (GISSI-HF investigators 2008; Rimm *et al*., 2018).

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In the Chicago Western Electric Study, a 30-year follow-up has been proclaimed that fish consumption positively affects CHD mortality, especially non-sudden deaths from myocardial infarction (MI). An ecological study conducted in 36 countries showed the favorable association between fish consumption and an attenuated risk of death from all-cause ischemic heart disease and stroke. The Nurses' Health Study, a recent study conducted with women, observed an inverse relationship between fish intake consumption and CHD death. Women who rarely ate fish (less than once per month) showed a 21%, 29%, 31%, and 34% higher risk of CHD when compared to women who ate 1-3 times a month, ate once a week, ate 2-4 times a week, and ate more than 5 times a week, respectively. For fish consumption 1 to 3 times per month, once per week, 2 to 4 times per week, and >5 times per week, respectively (Kris-Etherton 2002).

Every 20g/d increased fish consumption was associated with a 6% lower risk of HF. Consumption of fish 2-4 servings per week was associated with the most significant reduction in HF by 13%. Fish consumption can reduce the risk of stroke. Dose-response analysis exhibited that the risk of stroke decreased by 2% to 12%, with an increasing fish consumption of 100-700 g/week(1-4 servings/week). Finally, fatty fish consumption is recommended for significant triglycerides and HDL levels (Li *et al*., 2013; Alhassan *et al*., 2017; Li *et al*., 2020).

Previous and current data from studies showed that basal 3-PUFA levels in the heart were relatively high, and dietary omega-3 supplementation resulted in a substantial increase in omega-3 uptake in the heart. To examine the omega 3 distribution in the heart, they measured omega-3 levels in isolated cardiac myocytes and non-myocytes in every 3 groups of mice supplemented with Fish Oil (FO), EPA, and DHA, respectively. Surprisingly, dietary supplementation with 3-PUFAs failed to enhance EPA levels in either cardiac myocytes or nonmyocytes, with EPA levels in nonmyocytes (fibroblasts are the primary component of this cell fraction) moderately reduced by the FO diet. In contrast, DHA levels were increased by all three supplementations and uniformly across all cell types (Eclov *et al*., 2015).

In recent years, researchers have turned their attention towards the use of dietary supplements with their health potentials. There has been a considerable rising in scientific researches about natural healthy foods and their potential protective effects on heart health. The use of supplements is on the rise due to the several health benefits attributed to them. The beneficial role of n-3 PUFAs on blood lipids, cardiac electrophysiology, endothelial function, and blood pressure has been emphasized. Recently, valuable natural compounds and nutrients have gained importance in the developed countries, as social awareness focused on human health.

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Conflict of interest

Authors have no conflict of interest on this work.

References

Alhassan A., Young J., Lean M. E. J. and Lara J., 2017. Consumption of fish and vascular risk factors: A systematic review and meta-analysis of intervention studies. *Atherosclerosis*, 266, 87–94. https://doi.org/10.1016/j.atherosclerosis.2017.09.028

Block R. C., Liu L., Herrington D. M., Huang S., Tsai M. Y., O'Connell T. D. and Shearer G. C., 2019. Predicting Risk for Incident Heart Failure With Omega-3 Fatty Acids. *JACC: Heart Failure*, 7(8), 651-661. https://doi.org/10.1016/j.jchf.2019.03.008

Değertekin M., Erol Ç., Ergene O., Tokgözoğlu L., Aksoy M., Erol MK., Eren M., Şahin M., Eroğlu E., Mutlu B. and Kozan Ö., 2012. Heart Failure Prevalence and Predictors in Turkey: HAPPY Study. *Archives of The Turkish Society of Cardiology*, 404, 298-308. https://doi.org/10.5543/tkda.2012.65031

Donat-Vargas C., Bellavia A., Berglund M., Glynn A., Wolk A. and Akesson A., 2020. Cardiovascular and cancer mortality in relation to dietary polychlorinated biphenyls and marine polyunsaturated fatty acids: a nutritional-toxicological aspect of fish consumption. *Journal of Internal Medicine*, 287; 197–209. https://doi.org/10.1111/joim.12995

Eclov J. A., Qian Q., Redetzke R., Chen Q., Wu S. C., Healy C. L., Steven B., Harmon E., Shearer GC. and O'Connell T. D., 2015. EPA, not DHA, prevents fibrosis in pressure overload-induced heart failure: potential role of free fatty acid receptor 4. *Journal of Lipid Research,* 56(12), 2297–2308. https://doi.org/10.1194/jlr.M062034

Franco J., Formiga F., Trullas J.-C., Salamanca Bautista P., Conde A., Manzano L., Quirós R., Franco GA., Ezquerro AM. and Montero-Pérez-Barquero, M., 2017. Impact of prealbumin on mortality and hospital readmission in patients with acute heart failure. *European Journal of Internal Medicine*, 43, 36–41. https://doi.org/10.1016/j.ejim.2017.05.009

GISSI-HF investigators, 2008. Effect of n-3 polyunsaturated fatty acids in patients with chronic heart failure (the GISSI-HF trial): a randomised, double-blind, placebo-controlled trial. *The Lancet*, 372(9645), 1223–1230. https://doi.org/10.1016/S0140-6736(08)61239-8

Kris-Etherton, P. M., 2002. Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease. *Circulation,* 106(21), 2747–2757. https://doi.org/10.1161/01.CIR.0000038493.65177.94

Li , Y. H., Zhou, C. H., Pei, H. J., Zhou, X.L., Li, L. H, Wu, Y. J. and Hui, R.T., 2013. Fish consumption and incidence of heart failure: a meta-analysis of prospective cohort studies. *Chinese Medical Journal,* 126(5), 942-948.

[DOI: 10.52547/ijaah.7.2.1]

Li, N., Wu, X., Zhuang, W., Xia, L., Chen, Y., Wu, C., Raod, Z., Due, L., Zhaob, R.,Yib, M., Wanb, Q. and Zhou, Y., 2020. Fish consumption and multiple health outcomes: umbrella review. *Trends in Food Science and Technology*. 99, 273-283. https://doi.org/10.1016/j.tifs.2020.02.033

Metra, M. and Teerlink, J. R., 2017. Heart failure. *The Lancet*, 390(10106), 1981–1995. https://doi.org/10.1016/S0140-6736(17)31071-1

Özaltun, B. and Sevindik, M., 2020. Evaluation of the effects on atherosclerosis and antioxidant and antimicrobial activities of Agaricus xanthodermus poisonous mushroom. The European Research Journal, 6(6), 539-544. https://doi.org/10.18621/eurj.524149

Punia S., Sandhu K. S., Siroha A. K. and Dhull S. B., 2019. Omega 3-Metabolism, Absorption, Bioavailability and health benefits- A review. *PharmaNutrition,* 10, 100162. https://doi.org/10.1016/j.phanu.2019.100162

Rimm, E. B., Appel, L. J., Chiuve, S. E., Djoussé, L., Engler, M. B. Kris-Etherton, P. M., Mozaffarian, D., Siscovick, D. S. and Lichtenstein, A. H., 2018. Seafood Long-Chain n-3 Polyunsaturated Fatty Acids and Cardiovascular Disease: A Science Advisory From The American Heart Association. *Circulation,* 138(1), e35–e47. https://doi.org/10.1161/CIR.0000000000000574

Saravanan, P., Davidson, N. C., Schmidt, E. B. and Calder, P. C., 2010. Cardiovascular effects of marine omega-3 fatty acids. *The Lancet,* 376(9740), 540–550. https://doi.org/10.1016/S0140-6736(10)60445-X

Selamoglu, M., 2021. Importance of the cold chain logistics in the marketing process of aquatic products: An updated study. *Journal of Survey in Fisheries Sciences,* 8(1), 25-29.

Selamoglu, Z., 2018a. Selenium compounds for fish health: An update. *Journal of Survey in Fisheries Sciences,* 4(2), 1-4. https://doi.org/10.18331/SFS2018.4.2.1

Selamoglu, Z., 2018b. The Using of Honeybee products in Fishery and Apitherapy: A mini-review. *Iranian Journal of Aquatic Animal Health,* 4(1), 124-128. https://doi.org/10.29252/ijaah.4.1.124

Sevindik, M., Ozdemir, B., Bal, C., and Selamoglu, Z., 2021. Bioactivity of EtOH and MeOH Extracts of Basidiomycetes Mushroom (*Stereum hirsutum*) on Atherosclerosis. Archives of Razi Institute, 76(1), 87-94.

Sevindik, M., Özdemir, B., Braidy, N., Akgül, H., Akata, İ. and Selamoğlu, Z., 2021. Potential Cardiogenic Effects of Poisonous Mushrooms. *Mantar Dergisi*, 12(1), 80-86.

Wallin, A., Di Giuseppe D., Orsini N., Patel P. S., Forouhi N. G. and Wol, A., 2012. Fish Consumption, Dietary Long-Chain n-3 Fatty Acids, and Risk of Type 2 Diabetes: Systematic review and meta-analysis of prospective studies. *Diabetes Care*, 35(4), 918–929. https://doi.org/10.2337/dc11-1631

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