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The relationship between omega-3 fatty acids and blood pressure

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Abstract

Omega-3 fatty acids are a group of polyunsaturated fatty acids that play a critical role in the human body. The three main types of omega-3 fatty acids are alpha-linolenic acid, eicosapentaenoic acid and docosahexaenoic acid. This review describes characteristics of omega-3 fatty acids and their ability to reduce blood pressure and improve cardiovascular health.

Keywords health policy; outcomes research

Background

Omega-3 fatty acids

Fatty acids are lipids made up of long hydrocarbon chains that possess a carboxylic acid at the hydrophilic end and a methyl group at the hydrophobic end. Saturated fatty acids possess only single bonded carbons and are solid at room temperature. Unsaturated fatty acids contain at least one double-bonded carbon–carbon bond and are liquid at room temperature. Monounsaturated fatty acids possess a single double bond, while polyunsaturated fatty acids (PUFAs) possess more than two double bonds (cf., Figure 1). Omega-3 fatty acids are PUFAs that contain the first of many double bonds at the third carbon atom from the methyl end.[1] There are also omega-6 fatty acids and omega-9 fatty acids which contain their first double bonds at the sixth and ninth carbon atom from the methyl end respectively.[2]

There are several types of omega-3 fatty acids. The most significant are alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Figure 1). ALA is an 18-carbon chain fatty acid commonly found in plants such as canola, flaxseed and walnuts. ALA is mainly used for energy storage in the body.[3] Several studies have reported a link between ALA and cardiovascular disease. In a meta-analysis conducted in 2012, it was concluded that higher ALA consumption, either self-reported as a dietary component, or measured directly in blood or adipose tissue, was associated with a moderately lower risk of cardiovascular disease.[4] ALA is considered an essential fatty acid in our diet because it is necessary for health, but cannot be synthesised by humans. After it enters the human body, it can be converted to EPA or DHA.[5] More commonly, EPA and DHA enter the human body through consumption. EPA is a 20-carbon chain fatty acid commonly found in seafood.[3] There have been reports correlating EPA intake with reduced symptoms of depression. Recent research has suggested that depressed individuals are more likely to develop cardiovascular disease.[6] Depressed individuals have been shown to have higher levels of C-reactive protein (CRP).[7] Studies have shown that increased CRP levels are associated with increased coronary heart disease risk.[8] This relationship suggests that the ability of omega-3 fatty acids to reduce depression would also have a positive impact against cardiovascular disease. Studies have shown high intake of dietary PUFA is associated with lower CRP levels,[9] thus targeting both illnesses. DHA is a 22-carbon chain fatty acid that is also abundant in seafood.[10] It plays a critical role in brain function and development, especially in childhood.[11] While much research on PUFA and cardiovascular disease is limited to middle-age populations, a study conducted over the course of 14 years on 814 adolescents between the ages of 13–15 concluded that systolic and diastolic blood pressure was inversely associated with the intake of PUFAs, such that a higher intake of PUFAs was associated with reductions in blood pressure.[12]

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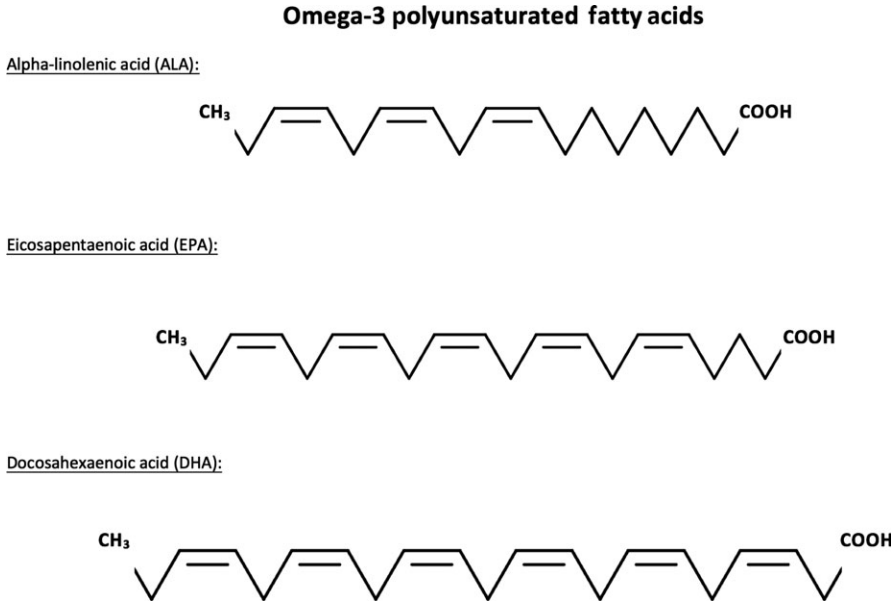

Figure 1 Chemical structures of alpha-linolenic acid, eicosapentaenoic acid and docosahexaenoic acid.

Dietary supplements are a popular source of omega-3 fatty acids. Supplemental omega-3 fatty acids can benefit those whose diet does not contain omega-3-rich foods. While consumption of large amounts of fish can increase omega-3 intake, supplements are the preferred choice due to concerns of mercury poisoning in large fish such as tuna. Mercury occurs naturally in the environment; it is also an environmental contaminant arising from human activities such as farming and burning coal.[13] Once mercury is absorbed into a body of water, it reacts with bacteria and is converted to methylmercury that fish can absorb.[14] When humans consume high amounts of large fish, levels of mercury may increase to toxic levels that can cause tremors, insomnia, memory loss and motor dysfunction. Therefore, the American Heart Association (AHA) recommends the consumption of small fish over large fish.[15]

Blood pressure

Blood pressure is the pressure that the blood exerts on the blood vessels of the cardiovascular system. Blood pressure consists of two measurements: systolic pressure measurement coincides with maximal contraction of the heart while pumping blood. The diastolic pressure measurement coincides with the time when the heart is at rest between beats. The mean arterial blood pressure is derived (2/3 diastolic, 1/3 systolic pressure) from these values. Abnormalities in blood pressure occur if an individual has blood pressures >120/80 mmHg or <90/60. The condition of high blood pressure is known as hypertension, of which there are two types: Primary hypertension, for which the causes have not all been determined, and secondary hypertension, which is caused by underlying conditions such as kidney disease and adrenal gland abnormalities.[16]

There are several factors that contribute to the development of hypertension. Smoking acutely raises blood pressure. Additionally, the chemicals in tobacco can damage the lining of blood vessel walls. This can cause arteries to hypertrophy, narrowing the lumen of the blood vessel, thereby increasing blood pressure by increasing resistance to flow. Second-hand smoke from a variety of sources also has adverse effects on the cardiovascular system.[17] Obesity also contributes to hypertension. The more one weighs, the more blood is necessary to supply oxygen and nutrients to the tissues. As the volume of blood circulating through blood vessels increases, the pressure on the artery walls does as well.[18] Diet also plays a role in blood pressure. An excess of salt or a lack of potassium may contribute to the development of hypertension. Too much sodium causes the body to retain fluid, thus increasing blood pressure. Potassium balances the amount of sodium in the body. Without a proper diet of potassium, too much sodium will accumulate in the blood.[19] Sustained high blood pressure can damage the cardiovascular system, contributing to atherosclerosis, ruptured aneurisms or stroke. High blood pressure can damage the endothelial cells lining the arterial lumen over time through increased shear stress. This may also lead to atherosclerosis or the build-up of plaque in the lumen of arteries with damaged endothelium. As the walls thicken with the deposits, they calcify and become brittle, restricting the flow of blood.[20] Damaged artery walls in the brain may also increase the probability of vessel rupture, causing a haemorrhagic stroke.[21]

There are several treatment options for hypertension. Angiotensin-converting enzyme (ACE) converts angiotensin I to angiotensin II, activating AT_1 receptors, causing blood vessels to constrict and thereby increase blood pressure. ACE inhibitors decrease ACE activity, resulting in the relaxation of blood vessels, leading to lower blood pressure and less oxygen demand by the heart. AT1 receptor blockers (ARBs) bind directly to AT1 receptors on vascular smooth muscle surrounding blood vessels, preventing the attachment of angiotensin II to the AT1 receptor. This

causes blood vessels to enlarge, and blood pressure is reduced.[22] Diuretics are commonly prescribed to rid the body of excess salt and water, thus relaxing the blood vessel walls and lowering blood pressure. Diuretics are typically combined with other medications. Beta-blockers work to block the effects of epinephrine. Beta-blockers relax the heart by decreasing its output of blood thereby lowering blood pressure. Calcium channel blockers decrease the movement of calcium into the heart and blood vessel walls. Typically, when calcium enters these cells, it promotes the contraction of the heart. Therefore, calcium channel blockers work to decrease the rate and force of contraction, while also allowing the blood vessels to dilate, reducing resistance to blood flow thereby decreasing blood pressure. Most importantly, however, lifestyle changes are necessary to make a substantial difference. This includes a change in diet, smoking cessation, limitation of alcohol consumption and regular exercise. Foods rich in omega-3 fatty acids such as fatty fish are becoming a popular addition to diets focused on lowering blood pressure.[23] This review seeks to highlight studies that have tested the effectiveness of using omega-3 fatty acids to reduce blood pressure in hypertensive and normotensive populations.

Hypertension is associated with increased risk for cardiovascular disease.[24] There have been several studies that show a decrease in blood pressure as little as 2 mmHg can reduce the occurrence of stroke and coronary heart disease.[25] A 2 mmHg reduction in diastolic blood pressure can result in a 17% decrease in the prevalence of hypertension, 6% reduction in the risk of coronary heart disease and a 15% reduction in risk of stroke and transient ischaemic attacks.[26] In normotensive population, reductions in systolic and diastolic blood pressure from 123 to 114 mmHg and 81 to 73 mmHg respectively, can reduce the risk of stroke and ischaemic heart disease.[27] Similar results were reported from a study of a normotensive population divided into optimal, normal and high normal blood pressures.[28] Therefore, even small changes in blood pressure in normotensive individuals can reduce the incidence of cardiovascular disease.

While research has shown how different sources of omega-3 fatty acids affect lipid profile and cytokine gene expression, there is a lack of research to determine the mechanisms whereby different sources of omega-3 fatty acids affect blood pressure.[29,30] It is suggested that further research is necessary to adequately study this topic to determine how the dietary source of omega-3 fatty acids plays a role in lowering blood pressure and differentially affecting systolic and diastolic blood pressure. It is suggested that DHA plays a more favourable role in decreasing blood pressure, but this needs to be further studied.[31]

The relationship between omega-3 fatty acids and blood pressure

The relationship between omega-3 fatty acids and cardiovascular disease was first observed in the Greenland Eskimo Population in the 1970's. The discovery of the low cardiovascular mortality rate in Greenland Eskimos compared to that of Danish control subjects stimulated inquiry into the effect of an omega-3 PUFA-rich diet on the incidence of cardiovascular disease. The Greenland Eskimo's diet consists of large amounts of seal and fish, which are very rich in PUFAs.[32] As then, numerous studies have shown a relationship between an omega-3-rich diet and a lower incidence of cardiovascular disease. According to the AHA, omega-3 fatty acids slightly lower blood pressure.[15] Although the exact mechanism behind the action is unclear, there are several possible explanations that illustrate this effect.

In a study conducted on spontaneously hypertensive rats (SHR), a diet containing 20% DHA-enriched oil reduced systolic blood pressure and vascular wall thickness in the coronary artery and aorta.[33] Increased vascular wall thickness is a characteristic of hypertension. It was noted that the coronary artery wall was not hypertrophic, and the lumen was wider in the DHA-fed SHR versus the untreated SHR group. This suggests that DHA supplementation plays a role in the prevention of vascular smooth muscle hypertrophy. In a similar study of SHR with the same diet, both plasma aldosterone levels and production of arachidonic epoxides by renal microsomes decreased in the DHA-fed group by 33% and 17% respectively. Angiotensin II acting upon the adrenal glomerulosa is a major stimulus for aldosterone synthesis and release.[34,35] This data suggests a possible blunting of the renin-angiotensin system by DHA reflected by the decreased adrenal synthesis of aldosterone. This may be a mechanism by which DHA lowers blood pressure.

Table 1 Omega-3 fatty acid supplementation and their effects on cardiovascular measurements

Measurement	Results	Citations
Systolic blood pressure	Significant decrease	31,44–46,50–52,54
	Insignificant decrease	**48,52–54**
Diastolic blood pressure	Significant decrease	46,51–54
	Insignificant decrease	**48,50,52,54**
	No change	45
Plasma triacylglyceride	Significant decrease	44
Ambulatory blood pressure	Significant decrease	47
Mean arterial pressure	Significant decrease	49
Heart rate	Significant decrease	49
Pulse pressure	Significant decrease	**51**
Basal heart rate	Significant decrease	**51**
Total cholesterol	Significant decrease	**53**
Low-density lipoprotein cholesterol	Significant decrease	**53**
High-density lipoprotein cholesterol	Significant increase	**53**

Studies of hypertensive populations are indicated in bold.

Another theory is that DHA-mediated changes in the metabolism of renal arachidonic acid may lead to this same effect. This is based upon the decreased levels of arachidonic epoxides, such as epoxyeicosatrienoic acids (EETs) in hypertensive rats.[36] Studies have shown that the inhibition of soluble epoxide hydrolase (sEH), the enzyme that metabolises EETs to form dihydroxyeicosatrienoic acids (DHETs) can decrease blood pressure. This pathway needs to be further explored but has promise for the future understanding of the mechanisms whereby PUFAs lower blood pressure.[37] These are some of the possible mechanisms in which omega-3 fatty acids may affect blood pressure. A detailed discussion of all the possible mechanisms of omega-3 fatty acids and blood pressure is beyond the scope of this review. Further studies are necessary to describe the exact mechanism.

The renin-angiotensin system is a critical hormone system in the body. Angiotensin II is an important hormone that regulates cardiovascular homoeostasis through thirst, vasoconstriction, the production of aldosterone, sodium reabsorption and water reabsorption to increase blood pressure.[38] Recent studies have shown that angiotensin II is a proinflammatory mediator in autoimmune diseases. ACE inhibitors and ARBs are agents used to block the renin-angiotensin system to reduce blood pressure in those with hypertension.[39] Studies have shown ACE inhibitors may also be effective in reducing vascular inflammation.[40] Omega-3 fatty acids have been shown to reduce angiotensin II formation by blocking ACE activity, thus preventing vasoconstriction and ultimately reducing blood pressure.[41] Recent research suggests the omega-3 fatty acids have anti-inflammatory effects.[42] Arachidonic acid is an omega-6 fatty acid that is a precursor of proinflammatory substances. Studies have shown EPA or DHA feeding in animal models and the use of fish-oil supplements in humans reduce the production of PGE_2, an arachidonic acid-derived proinflammatory eicosanoid, decreasing its proinflammatory actions. Omega-3 fatty acids also give rise to anti-inflammatory lipid mediators, such as resolvins and protectins, which are formed from EPA and DHA respectively.[43]

Clinical studies of omega-3 fatty acids and blood pressure

Omega-3 fatty acids have been shown to play a critical role in the regulation of blood pressure in humans. Although the exact mechanism of action is unknown, there is a defined relationship between the two factors. Several studies have tested the effectiveness of these PUFAs as possible treatments for hypertension. The studies include those performed on normotensive individuals and hypertensive individuals to determine if there is a differential effect (Table 1).

Normotensive population studies

A crossover randomised study conducted in 2012[44] sought to examine the effect of an omega-3 PUFA fish-oil dietary supplement on cognitive performance and cardiovascular risk markers. All 40 healthy subjects aged 51–72 participated in a 5-week-long treatment period with 3 g of supplementation and 5-week long placebo period over the course of the study. There was a significant reduction in systolic blood (7 ± 2 mmHg ($p < 0.001$)) and plasma triacylglycerides in the omega-3 PUFA treatment period compared to the control treatment period, suggesting a potential therapeutic use.

Another study conducted in 2015[45] in the rural town of Atahualpa, Ecuador sought to discover the effect of a primarily fish diet on blood pressure in 677 villagers aged 40 or older. The ancestral diet of the villagers is rich in wild-caught fish and carbohydrates, but poor in meat and dairy products with most meals being cooked at home. Participants were asked to quantify their traditional weekly consumption of the different species of fish which were characterised for oiliness based upon their fat content. Using regression models, the researchers evaluated if dietary intake of oily fish lowered blood pressure. The results indicated that with every serving of oily fish consumed per week (one serving = 140 g), the systolic blood pressure significantly decreased by 2.3 mmHg per serving, up to five servings. There was no relationship between diastolic blood pressure and fish serving. The study suggested that oily fish consumption reduces systolic blood pressure.

A meta-analysis conducted in 2014 by a consulting firm[46] sought to analyse the effect of EPA and DHA on blood pressure in randomised controlled trials. The analysis evaluated studies that examined the effects of EPA and DHA on blood pressure in nonhospitalised adults over the age of 18 over a 3-week period. The meta-analysis concluded that supplementation of EPA and DHA caused a significant reduction in blood pressure in normotensive (systolic blood pressure = −1.25 mmHg, diastolic blood pressure = −0.62 mmHg) and hypertensive (systolic blood pressure = −4.51 mmHg and diastolic blood pressure = −3.05 mmHg) subjects. In addition, the study demonstrated that the combined supplementation may be just as effective and sometimes even more effective than lifestyle changes such as increased physical activity and the reduction in sodium and alcohol intake for lowering blood pressure among hypertensive individuals not taking antihypertensive medications. The results are clinically important because they show that EPA and DHA supplementation may be an alternative treatment for those with and without hypertension. However, there needs to be further studies to evaluate the dose–response relationship of EPA/DHA supplements on blood pressure reductions.

A double-blind study[47] conducted on 56 overweight, mildly hyperlipidemic men sought to test the different effects of EPA and DHA on blood pressure. The subjects were given 4 g per day of EPA, DHA or olive oil placebo for 6 weeks. It was concluded that only DHA caused a significant decrease in 24-h and daytime ambulatory blood pressure. These results are significant because they suggest DHA is the main omega-3 fatty acid with blood pressure-lowering effects. A majority of studies that have tested the effects of omega-3 fatty acids typically do in a combined supplementation of EPA and DHA. Therefore, this observation will have important implications on human health and nutrition.

A review conducted in 2012[31] sought to evaluate the available evidence about the clinical effect of omega-3

PUFAs on blood pressure control. The review concluded that the effects of omega-3 PUFAs on blood pressure are not consistent, and the reduction obtained in different studies is mild. However, in this review, studies using doses >3 g/day supplemented as fish or fish oil reported significant lowering of systolic blood pressure in elderly and hypertensive subjects. This too is clinically significant because it shows that further clinical studies are necessary to determine dose–response relationships and the variations in efficacy of omega-3 PUFA-mediated blood pressure reduction in heterogeneous populations.

The International Study of Macro- and Micro-nutrients and Blood Pressure (INTERMAP)[48] is an international cross-sectional epidemiologic study of 4680 individuals aged 40–59 from the United States, United Kingdom, China and Japan. Due to inconsistencies in results of several studies in determining the effect of omega-3 PUFAs in the prevention of cardiovascular disease and influence on blood pressure, the study sought to determine the effect of omega-3 PUFAs on normotensive individuals. Patients reported associations of omega-3 PUFA intake and blood pressure were measured four times over a course of 3 years. The main food groups supplying omega-3 PUFAs were divided into total, linolenic acid (largely from vegetable sources), long-chain ω-3 PFA (largely from fish; EPA, DHA, docosapentaenoic acid (DPA)). It was determined that there was a small reduction in normotensive individuals. Therefore, one can conclude that there was very little effect of omega-3 PUFA on blood pressure. This serves as a contrast to the results of several other studies in which omega-3 fatty acid supplementation was associated with a decrease in blood pressure.

In a randomised double-blinded crossover study,[49] the dose-dependent effect of EPA and DHA supplementation in 26 adults with no conditions other than moderate hypertriglyceridemia was explored at rest and during stress. The effects of low dose EPA + DHA supplementation (0.85 g per day), high dose EPA + DHA supplementation (3.4 g per day) and placebo were explored with 8-week treatment period and 6-week washout periods. The results showed that treatment with the high dose of omega-3 fatty acid significantly reduced mean arterial pressure by 2 mmHg, while the low dose had no effect. The high dose also significantly decreased heart rate. It was concluded that omega-3 fatty acids have a dose-dependent effect on blood pressure.

Hypertensive population studies

A placebo-controlled observational study conducted in 2012[50] on 100 hypertensive subjects sought to determine the effects of omega-3 PUFA supplementation on the blood pressure of hypertensive patients. The study also determined whether male and female hypertensive patients respond differently to PUFAs. The subjects were given a 1 g fish-oil tablet, with omega-3 PUFAs or placebo, to be taken daily for 3 months. The omega-3 PUFA group had a statistically significant reduction in both the systolic and diastolic blood pressures after 3 months treatment compared to the placebo group. There was a significant 9.63 mmHg reduction in the systolic blood pressure of men. Diastolic blood pressure of men and both the systolic and diastolic blood pressures of the women were also lower in the omega-3-treated groups compared to control, but these decreases were not statistically significant. Again, these results are clinically significant because they show that omega-3 supplements have a potential role as a treatment option for hypertension.

An open-label study conducted in 2012[51] sought to analyse the effect of omega-3 PUFA supplementation on 63 male and 25 female subjects with untreated primary hypertension, but no other diseases, except hypertriglyceridemia. The subjects were prescribed 3 g of a supplementation that contained both EPA and DHA to be taken daily for 2 years. The study concluded that both systolic blood pressure (2.6 ± 2.5 mmHg ($p = 0.001$)) and diastolic blood pressure (1.4 ± 3.1 mmHg ($p < 0.001$)) significantly decreased. There was also a significant decrease in pulse pressure and basal heart rate. The results are again clinically important because they show that EPA and DHA supplementation may be an alternative treatment for those with hypertension who are unable to or choose not to take antihypertensive medications. However, further studies are necessary to evaluate the potential benefits of increasing blood levels of omega-3 PUFAs to determine an optimal dose.

A systematic review[52] sought to determine the effectiveness of fish-oil supplements in lowering blood pressure in both normotensive and hypertensive populations. A total of 17 studies were evaluated in which adults received fish-oil supplements with a minimum of 8 weeks of follow-up. Meta-analysis was used to analyse the effects of systolic and diastolic blood pressure with the inverse variance method. It was concluded that in the eight studies with hypertensive subjects, there was a statistically significant reduction in systolic (2.56 mmHg) and diastolic (1.47 mmHg) blood pressure; while in the seven studies with normotensive subjects, there was nonsignificant reduction in systolic and diastolic blood pressure. There was also no significant relationship in the dose of fish oil and effect on blood pressure. This study is significant because it suggests that fish-oil supplementation seems to reduce blood pressure in hypertensive subjects, while playing no effect on normotensive subjects.

A double-blind randomised study[53] focused on the supplementation of Omega3Q10, a marine omega-3 PUFA formulation in older adults with hypertension and or hypercholesterolemia. There was a total of 97 participants who enrolled to receive a 12-week supplementation of either Omega3Q10 or soya bean oil. The study concluded that Omega3Q10 supplementation significantly decreased diastolic blood pressure, total cholesterol and low-density lipoprotein (LDL) cholesterol and significantly increased high-density lipoprotein (HDL) cholesterol. In addition, a significantly greater proportion of the participants who received Omega3Q10 supplementation became free from headache, palpitation and chest tightness symptoms. These symptoms are common manifestations of hypertension. These results are significant in suggesting that omega-3 PUFA supplementation may play a role in alleviating symptoms in those suffering from hypertension.

A meta-analysis[54] sought to determine the overall effect of omega-3 PUFA supplementation on blood pressure. Of

the total 17 controlled clinical trials that were analysed, 11 of them studied normotensive populations while six studied hypertensive populations. There was a significant reduction in systolic blood pressure in four studies (two normotensive, two hypertensive) and a significant reduction in diastolic blood pressure in five studies (one normotensive, four hypertensive). It was concluded that omega-3 PUFA supplementation >3 g/day can lead to a moderate decrease in blood pressure in hypertensive subjects, and that the reductions were dose-related. This study suggests that more research is necessary to determine the long-term efficacy of omega-3 PUFA supplementation as a antihypertensive treatment method. However, its effect on normotensive subjects is minimal.

Health policy

Professional organisations seem to disagree on the health benefits of omega-3 fatty acids. The AHA affirms that omega-3 fatty acids lower blood pressure. It is recommended to eat fish two servings of fatty fish per week. This should include small fish, for examples sardines, because large fish may contain high levels of mercury. Those suffering from coronary artery disease should take additional supplementation as well.[15] The American College of Cardiology (ACC) has published several papers discussing omega-3 fatty supplementation on cardiovascular disease. There is general consensus that blood pressure is reduced by omega-3 PUFA intake. Omega-3 fatty acids seem to affect many different molecular pathways, but its exact mechanism on reducing blood pressure is unclear.[55,56] In the *2013 ACC Foundation/AHA Guideline for the Management of Heart Failure*, it is stated that omega-3 fatty supplementation leads to risk reduction in fatal and nonfatal cardiovascular events.[57] In the *2015–2020 Dietary Guidelines for Americans*, the U.S. Department of Health and Human Services recommends 8 ounces of seafood per week. It is rich in EPA and DHA which has been associated with reduced cardiac death among individuals with and without cardiovascular disease.[58] The European Society of Cardiology, however, published that the effect of DHA and EPA on cardiovascular disease is debatable in *2016 European Guidelines on Cardiovascular Disease Prevention in Clinical Practice.* Instead, ACE inhibitors and ARBs are recommended as the first line of defence against conditions such as hypertension.[59] This may be because there is strong evidence that supports the reduction of blood pressure with such medications over supplementations such as omega-3 fatty acids. Ultimately, a majority of professional organisations support the concept that omega-3 fatty acids can positively impact the cardiovascular system; however, it should not be used as the primary treatment method against cardiovascular disease. There are existing treatments that have a greater positive impact than PUFA therapy.

Conclusion

Omega-3 PUFAs have many health benefits. ALA, EPA and DHA are the three major omega-3 fatty acids that are consumed by humans. Omega-3 PUFAs can be consumed either through diet or dietary supplements such as fish-oil supplements. Since the discovery of the low cardiovascular mortality rate in Greenland Eskimos in the 1970s, there has been much discussion on the effect of an omega-3 PUFA-rich diet on the incidence of cardiovascular disease. Numerous studies have defined a relationship between increased omega-3 fatty acid intake, reduced blood pressure and improved cardiovascular health. However, there is an inconsistency in this relationship among published studies. This beneficial relationship may lead to novel therapies for reducing blood pressure. However, further studies are necessary because the mechanism behind the relationship is not entirely understood. Specifically, the mechanism behind the effect of omega-3 fatty acids on blood pressure as well as the effect of the dosage of EPA and DHA needed for beneficial blood pressure reduction needs to be determined. Currently, there are several options for treatment of hypertension. However, a substantial proportion of the population are still hypertensive. With greater use in the future, either through diet or supplementation, omega-3 fatty acids may complement the therapeutic actions of medications used to treat high blood pressure. Further studies are necessary to better define this relationship. Currently, a majority of professional organisations encourage the consumption of omega-3 fatty acids to protect individuals from cardiovascular disease; however, continuance of prescribed antihypertensive medication is still necessary.

Declarations

Conflict of interests

The Author(s) declare(s) that they have no conflict of interests to disclose.

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Authors' contributions

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