

# Can you hear me now? The quest for better guidance on omega-3 fatty acid consumption to combat hearing loss

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Few things are more important to an older adult than safety and high health-related quality of life. Equally relevant is the ability of those surrounding such an adult to understand that individual's functionality. However, achieving this reality is not simple because most people do not have experience living with older adults who have multiple, complex or even distinct health problems, including hearing loss.

Although a large proportion of adults retain good hearing throughout life, age-related hearing loss (A-RHL) is quite common among elderly individuals (1). Indeed, A-RHL is the most common sensory deficit in older adults (1,2) and occurs in response to a multifactorial process associated with insults to the auditory system that are received throughout an individual's life. These insults arise from ageing, noise damage, genetic susceptibility, otological disorders and exposure to ototoxic agents (1,2). A-RHL is characterized by reduced hearing sensitivity and decreased understanding of speech in noisy environments, as well as slowed central processing of acoustic information and impaired localization of sound sources (1,2). Epidemiologically, the hearing loss data reported in the literature are quite serious. In older adults, hearing loss is the second most common condition causing handicap, following only arthritis (3). As such, A-RHL is a major social and public health problem (1,2). Furthermore, 10% of the population has such significant hearing loss that communication may be impaired, and this rate increases to 40% in individuals older than 65 years (1,2,4). It is notable that 80% of all hearing loss cases affect the elderly population (1,2,5). Another significant issue in both developed and developing countries is the fact that A-RHL leads to adverse effects on the physical, cognitive, emotional, behavioral and social functioning of older adults, dramatically reducing the quality of life of these individuals (1,2,6). For treating A-RHL, it has been established that when

hearing aids no longer provide an advantage, cochlear implantation may be effective for elderly patients, including those over eighty years old (2).

While no treatment is currently capable of restoring lost hearing, sophisticated experimental and human studies into hearing restoration have been conducted over the last decade (1,2). One goal to prevent hearing deterioration is the creation of strategies other than medical and surgical therapies that could be beneficial. Nutritional approaches, such as supplementation with omega-3 polyunsaturated fatty acids (omega-3 FAs), could have an interesting role in this context.

Omega-3 FAs, primarily eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are considered essential fatty acids (7-9). The designations "omega-3" or "n-3" describe long-chain fatty acids that possess a double bond located at the 3<sup>rd</sup> carbon from the end of the carbon chain (7-9). The human body cannot synthesize omega-3 FAs and they must therefore be obtained from food (10-12). Thus, the advantages and nutritional benefits of a diet rich in fish and other seafood are mainly related to the high-quality protein and high concentrations of EPA and DHA that are present in these animals (13-15). The fish species with the highest levels of omega-3 FAs and lowest levels of contaminants (e.g., methylmercury, polychlorinated biphenyls and dioxins) are anchovies, Atlantic herring, salmon, trout and sardines (13,16-20); as such, these are the best choices for consumption. Early reports from Bang and Dyerberg demonstrated that Greenland Eskimos, who have diets rich in omega-3 FAs, have a low incidence of cardiovascular disease. Following these reports, a series of animal and clinical studies were designed to evaluate the positive effects promoted by omega-3 FAs in human health and disease (10,21). A number of studies have reported that omega-3 FAs are clinically beneficial and reduce triglycerides, improve cardiac health and reduce the risk of death after myocardial infarction (22-24). Additionally, omega-3 FAs impact a variety of other bodily systems and can affect the outcomes of various diseases, including metabolic and inflammatory diseases, cancer, neurological disease and mental illness (7,17,25-30). Based on these facts, several national and international guidelines have been developed with vigorous recommendations for omega-3 FA consumption by the

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general population for the prevention of some chronic diseases. These recommendations include the consumption of at least 250 mg/day of long-chain omega-3 FAs or at least 2 servings/week of oily fish (31). These recommendations have been made regardless of variations in the natural consumption of omega-3 FAs among different populations and cultures.

With regard to hearing loss, the importance of omega-3 FA and fish consumption on the risk of A-RHL was elegantly demonstrated by Gopinath et al. (32). They showed that dietary intervention with omega-3 FAs may be useful in preventing or delaying the development of A-RHL. These benefits may be related to the ability of polyunsaturated fatty acids to promote healthy auditory function through the maintenance of adequate vascular supply to the cochlea (32,33). Additionally, polyunsaturated fatty acids attenuate inflammatory processes (32,34), decrease blood pressure and improve vascular reactivity or endothelial function (32,35). More recently, Curhan et al. (36) conducted a prospective cohort study to evaluate independent associations between consumption of total and specific types of fish, consumption of long-chain omega-3 FAs, and self-reported hearing loss in women. These associations were examined in 65,215 women who were followed from 1991 to 2009. In brief, after 1,038,093 person-years of follow-up, 11,606 cases of incident hearing loss were reported. Based on these data, the authors demonstrated that regular fish consumption (2 or more servings of fish per week) and higher intake of long-chain omega-3 FAs are associated with a lower risk of hearing loss in women. Martínez-Veja et al. (37) used a classical mouse model of early hearing loss (C57BL/6J mice) to demonstrate that long-term omega-3 FA supplementation exerts a protective effect on cochlear metabolism and progression of hearing loss.

Hearing loss in the elderly significantly impacts everyday life. Due to the aging of populations in developed and developing countries (1,2,38), A-RHL remains a problem for all social classes that extensive public health awareness campaigns should be created to address. Although future large prospective studies exploring the links between dietary omega-3 FAs and hearing health still need to be conducted (32), the proposal of using omega-3 FA dietary interventions to prevent hearing loss in older adults is innovative, practical to apply and expected to be useful. Finally, as a deeper understanding of the emerging role of omega-3 FA consumption in preventing A-RHL is essential for the design of better strategies to treat this condition, multidisciplinary approaches in clinical and experimental translational research are crucial at this time.

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## REFERENCES

- Huang Q, Tang J. Age-related hearing loss or presbycusis. *Eur Arch Otorhinolaryngol.* 2010;267(8):1179-91, <http://dx.doi.org/10.1007/s00405-010-1270-7>.
- Gates GA, Mills JH. Presbycusis. *Lancet.* 2005;366(9491):1111-20, [http://dx.doi.org/10.1016/S0140-6736\(05\)67423-5](http://dx.doi.org/10.1016/S0140-6736(05)67423-5).
- Bielefeld EC, Tanaka C, Chen GD, Henderson D. Age-related hearing loss: is it a preventable condition? *Hear Res.* 2010;264(1-2):98-107, <http://dx.doi.org/10.1016/j.heares.2009.09.001>.
- Ries PW. Prevalence and characteristics of persons with hearing trouble: United States, 1990-91. *Vital Health Stat* 10. 1994;188:1-75.
- Davis AC. Epidemiological profile of hearing impairments: the scale and nature of the problem with special reference to the elderly. *Acta Otolaryngol Suppl.* 1990;476:23-31, <http://dx.doi.org/10.3109/00016489109127252>.
- Mulrow CD, Aguilar C, Endicott JE, Tuley MR, Velez R, Charlip WS, et al. Quality-of-life changes and hearing impairment. A randomized trial. *Ann Intern Med.* 1990;113(3):188-94, <http://dx.doi.org/10.7326/0003-4819-113-3-188>.
- DeGiorgio CM, Scorza FA. Epilepsy & behavior: 15th anniversary research on omega-3 fatty acids for epilepsy. *Epilepsy Behav.* 2014; 40:124-5, <http://dx.doi.org/10.1016/j.yebeh.2014.09.065>.
- Calder PC. Omega-3 polyunsaturated fatty acids and inflammatory processes: nutrition or pharmacology? *Br J Clin Pharmacol.* 2013;75(3):645-62.
- Yates CM, Calder PC, Ed Rainger G. Pharmacology and therapeutics of omega-3 polyunsaturated fatty acids in chronic inflammatory disease. *Pharmacol Ther.* 2014;141(3):272-82, <http://dx.doi.org/10.1016/j.pharmthera.2013.10.010>.
- Davidson MH. Omega-3 fatty acids: new insights into the pharmacology and biology of docosahexaenoic acid, docosapentaenoic acid, and eicosapentaenoic acid. *Curr Opin Lipidol.* 2013;24(6):467-74, <http://dx.doi.org/10.1097/MOL.0000000000000019>.
- Ghasemifard S, Turchini GM, Sinclair AJ. Omega-3 long chain fatty acid "bioavailability": a review of evidence and methodological considerations. *Prog Lipid Res.* 2014;56:92-108, <http://dx.doi.org/10.1016/j.plipres.2014.09.001>.
- Leaf A, Kang JX, Xiao YF. Fish oil fatty acids as cardiovascular drugs. *Curr Vasc Pharmacol.* 2008;6(1):1-12, <http://dx.doi.org/10.2174/157016108783331286>.
- Castro-González MI, Méndez-Armenta M. Heavy metals: Implications associated to fish consumption. *Environ Toxicol Pharmacol.* 2008;26(3): 263-71, <http://dx.doi.org/10.1016/j.etp.2008.06.001>.
- Clarkson TW. The three modern faces of mercury. *Environ Health Perspect.* 2002;110 Suppl 1:11-23, <http://dx.doi.org/10.1289/ehp.02110s111>.
- Domingo JL, Bocio A, Falcó G, Llobet JM. Benefits and risks of fish consumption Part I. A quantitative analysis of the intake of omega-3 fatty acids and chemical contaminants. *Toxicology.* 2007;230(2-3):219-26, <http://dx.doi.org/10.1016/j.tox.2006.11.054>.
- Scorza CA, Cavalheiro EA, Calderazzo L, de Almeida AC, Scorza FA. Chew on this: Sardines are still a healthy choice against SUDEP. *Epilepsy Behav.* 2014;41:21-2, <http://dx.doi.org/10.1016/j.yebeh.2014.08.019>.
- Scorza FA, Cysneiros RM, Terra VC, Scorza CA, Cavalheiro EA, Ribeiro MO, et al. Omega-3 consumption and sudden cardiac death in schizophrenia. *Prostaglandins Leukot Essent Fatty Acids.* 2009;81(4): 241-5, <http://dx.doi.org/10.1016/j.plefa.2009.06.008>.
- Smith KM, Sahyoun NR. Fish consumption: recommendations versus advisories, can they be reconciled? *Nutr Rev.* 2005;63(2):39-46, <http://dx.doi.org/10.1111/j.1753-4887.2005.tb00120.x>.
- Jeejeebhoy KN. Benefits and risks of a fish diet: should we be eating more or less? *Nat Clin Pract Gastroenterol Hepatol.* 2008;5(4):178-9, <http://dx.doi.org/10.1038/ncpgasthep1067>.
- Fish: friend or foe? In addition to heart-healthy omega-3 fats, seafood can carry mercury and other toxins. For most people, the benefits of eating fish far outweigh the risks. *Harv Heart Lett.* 2007;17(6):4-6.
- Bang HO, Dyerberg J. Plasma lipids and lipoproteins in Greenlandic west coast Eskimos. *Acta Med Scand.* 1972;192(1-2):85-94, <http://dx.doi.org/10.1111/j.0954-6820.1972.tb04782.x>.
- Kris-Etherton PM, Harris WS, Appel LJ, American Heart Association. Nutrition Committee. Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. *Circulation.* 2002;106(21):2747-57, <http://dx.doi.org/10.1161/01.CIR.0000038493.65177.94>.
- De Caterina R. n-3 fatty acids in cardiovascular disease. *N Engl J Med.* 2011;364(25):2439-50, <http://dx.doi.org/10.1056/NEJMr1008153>.
- Gruppo Italiano per lo Studio della Sopravvivenza nell'Infarto miocardico. Dietary supplementation with n-3 polyunsaturated fatty acids and vitamin E after myocardial infarction: results of the GISSI-Prevenzione trial. *Lancet.* 1999;354(9177):447-55, [http://dx.doi.org/10.1016/S0140-6736\(99\)07072-5](http://dx.doi.org/10.1016/S0140-6736(99)07072-5).
- Calder PC. Functional Roles of Fatty Acids and Their Effects on Human Health. *JPEN J Parenter Enteral Nutr.* 2015;39(1 Suppl):18S-32S, <http://dx.doi.org/10.1177/0148607115595980>.
- Ellulu MS, Khaza' ai H, Abed Y, Rahmat A, Ismail P, Ranneh Y. Role of fish oil in human health and possible mechanism to reduce the inflammation. *Inflammopharmacology.* 2015;23(2-3):79-89, <http://dx.doi.org/10.1007/s10787-015-0228-1>.
- D'Eliseo D, Velotti F. Omega-3 Fatty Acids and Cancer Cell Cytotoxicity: Implications for Multi-Targeted Cancer Therapy. *J Clin Med.* 2016;5(2). pii: E15, <http://dx.doi.org/10.3390/jcm5020015>.



28. Wysoczański T, Sokoła-Wysoczańska E, Pękala J, Lochyński S, Czyż K, Bodkowski R, et al. Omega-3 Fatty Acids and their Role in Central Nervous System - A Review. *Curr Med Chem*. 2016;23(8):816-31, <http://dx.doi.org/10.2174/0929867323666160122114439>.
29. Mazza M, Pomponi M, Janiri L, Bria P, Mazza S. Omega-3 fatty acids and antioxidants in neurological and psychiatric diseases: an overview. *Prog Neuropsychopharmacol Biol Psychiatry*. 2007;31(1):12-26, <http://dx.doi.org/10.1016/j.pnpbp.2006.07.010>.
30. Marano G, Traversi G, Nannarelli C, Mazza S, Mazza M. Omega-3 fatty acids and schizophrenia: evidences and recommendations. *Clin Ter*. 2013;164(6):e529-37, <http://dx.doi.org/10.7417/CT.2013.1651>.
31. Mozaffarian D, Wu JH. Omega-3 fatty acids and cardiovascular disease: effects on risk factors, molecular pathways, and clinical events. *J Am Coll Cardiol*. 2011;58(20):2047-67, <http://dx.doi.org/10.1016/j.jacc.2011.06.063>.
32. Gopinath B, Flood VM, Rochtchina E, McMahon CM, Mitchell P. Consumption of omega-3 fatty acids and fish and risk of age-related hearing loss. *Am J Clin Nutr*. 2010;92(2):416-21, <http://dx.doi.org/10.3945/ajcn.2010.29370>.
33. Torre P 3rd, Cruickshanks KJ, Klein BE, Klein R, Nondahl DM. The association between cardiovascular disease and cochlear function in older adults. *J Speech Lang Hear Res*. 2005;48(2):473-81, [http://dx.doi.org/10.1044/1092-4388\(2005/032\)](http://dx.doi.org/10.1044/1092-4388(2005/032)).
34. Din JN, Newby DE, Flapan AD. Omega 3 fatty acids and cardiovascular disease--fishing for a natural treatment. *BMJ*. 2004;328(7430):30-5, <http://dx.doi.org/10.1136/bmj.328.7430.30>.
35. Bao DQ, Mori TA, Burke V, Puddey IB, Beilin LJ. Effects of dietary fish and weight reduction on ambulatory blood pressure in overweight hypertensives. *Hypertension*. 1998;32(4):710-7, <http://dx.doi.org/10.1161/01.HYP.32.4.710>.
36. Curhan SG, Eavey RD, Wang M, Rimm EB, Curhan GC. Fish and fatty acid consumption and the risk of hearing loss in women. *Am J Clin Nutr*. 2014;100(5):1371-7, <http://dx.doi.org/10.3945/ajcn.114.091819>.
37. Martínez-Vega R, Partearroyo T, Vallecillo N, Varela-Moreiras G, Pajares MA, Varela-Nieto I. Long-term omega-3 fatty acid supplementation prevents expression changes in cochlear homocysteine metabolism and ameliorates progressive hearing loss in C57BL/6J mice. *J Nutr Biochem*. 2015;26(12):1424-33, <http://dx.doi.org/10.1016/j.jnutbio.2015.07.011>.
38. Ciorba A, Bianchini C, Pelucchi S, Pastore A. The impact of hearing loss on the quality of life of elderly adults. *Clin Interv Aging*. 2012;7:159-63, <http://dx.doi.org/10.2147/CIA.S26059>.