



Research Article

Benefits of omega-3 polyunsaturated fatty acids to patients with oral and metabolic diseases

Da-Ming Liao¹ and Chieh Chen^{2*}¹Dental Department, Puli Christian Hospital, Taiwan²Division of Family Medicine, Hualien Armed Forces General Hospital, Taiwan

Received: 01 February, 2023

Accepted: 20 February, 2023

Published: 21 February, 2023

*Corresponding author: Chieh Chen, Division of Family Medicine, Hualien Armed Forces General Hospital, 970 No. 198, Minde 1st Street, Hualien city, Taiwan, Tel: 0928-698950; E-mail: guppy5230@yahoo.com.tw

ORCID: <https://orcid.org/0000-0001-5784-9855>

Keywords: Metabolic disorders; Dysglycemia; Insulin resistance; Oral disease; Long-chain omega-3 polyunsaturated fatty acids

Copyright License: © 2023 Da-Ming L, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

<https://www.peertechzpublications.com>

Check for updates

Abstract

The human body cannot produce omega-3 fatty acids and must obtain them from the diet. There are three types of omega-3 fatty acids that are needed by the human body, namely α -linolenic acid (ALA), Docosahexaenoic Acid (DHA) and Eicosapentaenoic Acid (EPA). Although studies have shown that omega-3 fatty acids cannot prevent or treat diabetes or heart diseases, they did improve the condition of insulin resistance and the level of triglycerides in the body. It is well known that being overweight leads to insulin resistance, which in turn leads to metabolic syndrome. Many animal experiments have already confirmed that long-chain omega-3 polyunsaturated fatty acids (n-3 PUFA) are beneficial in promoting insulin sensitivity. It inhibits nuclear transcription factor kappa B (NF κ B), which is a key transcription factor for gene expression of inflammatory cytokines. On the other hand, studies have also pointed out that omega-3 polyunsaturated fatty acids do not improve the function of the kidney's endothelial cells and high blood pressure in patients with type 2 diabetes.

Introduction

Type 2 diabetes is a metabolic disease characterized by hyperglycemia. It is estimated that the worldwide prevalence will increase from 171 million in 2000 to 366 million in 2030 [1]. Omega-3 fatty acids, in fish oil or linseed oil, can improve the sub-health status of patients with diabetes or dyslipidemia, such as insulin resistance, serum TG, HDL (high-density lipoprotein), etc., and regulate prostaglandin production [1]. Although the anti-inflammatory effect and triglyceride-lowering properties of long-chain omega-3 polyunsaturated fatty acids (n-3 PUFA) have been clinically proven, their inhibitory effect on body weight and the improvement of metabolic syndrome remain controversial [1-3]. There are numerous studies that support the positive impact of Omega-3 intake on teeth, gums and overall dental health. For instance, a study in 2010 revealed that consumption of fish oil can lower the risk of having gum disease.

The mechanisms by which n-3 PUFA may improve body composition and inhibit metabolic changes associated with obesity include regulating lipid metabolism, regulating fat or muscle hormones, such as adiponectin, leptin, etc., and reducing inflammation caused by adipose tissues. DHA (Docosahexaenoic Acid) and EPA (Eicosapentaenoic Acid) in omega-3 fatty acids cannot be produced by the human body and must be supplemented in the diet through fish or linseed oil, as well as nuts and other foods. Long-chain omega-3 polyunsaturated fatty acids can prevent inflammation by inducing the production of adiponectin. But studies have shown that supplementing fish oil in the healthy group does not improve insulin sensitivity. For the population of sub-health statuses, such as those having metabolic syndrome, such supplements will increase insulin sensitivity [1,3]. Clinically, diabetic patients may experience other common oral conditions such as gingivitis, periodontal disease, dental caries, dry mouth, angular cheilitis, burning sensation of



oral mucosa or tongue, fungal infection, lichen planus, etc. The symptoms include a burning sensation, dryness, bad odor, and dysfunctional taste perception. Besides common signs of periodontitis and tooth loss, there is a decrease in salivation that leads to a constant feeling of high temperature (burning) in the mouth, all of which are an indication of poor glycemic control. The delayed healing of the wound is also common in the oral cavity of diabetics, not to mention tooth hypersensitivity with paresthesia and gingival decay. Diabetic patients may experience disturbance in taste function. Fungal or bacterial infection is also common, as well as observing lichen planus-like lesions or angular cheilitis. All symptoms, such as periodontal disease, are more severe in patients with diabetes than in healthy people, which is probably due to higher A₁C. Given these patients with poor immune function, the accumulation of late-stage products of the glycation process in the body will trigger the inflammatory cells to systematically produce cytokines and cause a body-wide response. A diet rich in DHA and EPA omega-3s, whether through supplementation or as part of regular dietary choices, can help maintain gum health and keep teeth securely rooted, preventing tooth decay that can often form in the spaces between damaged gums and the tooth itself. The dental plaque will increase under this condition and is observed by an increase in inflammation of soft tissues around the teeth. These biofilms of microorganisms will further invade the gums and alveolar bones to cause the necrosis of tissues in the cavity [4].

Definition of metabolic disorders

Dysfunctional metabolism is often categorized as metabolic syndrome, encompassing a variety of early conditions of some chronic diseases, such as hypertension, coronary heart disease, diabetes, dyslipidemia, obesity, gout, etc. Some studies have pointed out that insulin resistance and hyperinsulinemia are closely related to metabolic dysfunction [5,6]. The blood in adipose tissues is generally filled with an abundance of free fatty acids, which inhibits the activities of insulin in the muscles and reduces the use of glucose; thus, elevating the level of blood sugar in the body. The rapid increase of glucose will force the pancreas to secrete more insulin to compensate, but unfortunately, fats are highly resistant to insulin, leading to a vicious cycle of hyperinsulinemia, a condition of increased insulin in the blood. Both conditions will contribute to an abnormal level of blood lipids, blood pressure, and systemic inflammation response, all of which may well lead to the final formation of atherosclerotic plaques to clog the blood vessels to cause myocardial infarction or ischemic cerebral infarction. Other associated metabolic diseases include fatty liver and diabetes. The overall evidence suggests that supplementation with long-chain omega-3s reduces and can positively remodel, atherosclerotic plaque formation.

Discussion

Prevention of metabolic disorders

Excessive adipose tissues in the body, especially around visceral organs, will produce free fatty acids and cause insulin resistance. Therefore, weight loss is a key factor in improving

metabolic syndrome. Regular physical activities can improve insulin sensitivity, blood sugar, blood pressure, and blood lipids. It also increases the concentration of HDL-C [7]. Omega-3 fatty acids are involved in the synthesis of some hormones that may inhibit inflammation and blood coagulation, as well as suppress some of the immune responses. Therefore, for patients with immunodeficiency or coagulation disorder, it may instead increase the risk of infection or bleeding. The American Heart Association recommends that the supplement of omega-3 fatty acids to reduce the risk of heart diseases, but it will not help to reduce the mortality of ischemic heart diseases or failure due to type 2 diabetes or pre-diabetic condition, as it has the risk of inducing cerebellar hemorrhage [8]. Although omega-3 fatty acids cannot improve the metabolism of carbohydrates and proteins in diabetic patients, it shows a promising result of lowering triglycerides and has been demonstrated in patients with the metabolic disorder to have decreased fatty acids due to improved lipolytic enzyme activities. Within the limitation of the review, omega-3 polyunsaturated fatty acids seem to have a positive effect on periodontal healing following periodontal therapy. Chronic periodontitis patients should be counseled to incorporate omega-3 fatty acids in their diet along with standard periodontal therapy.

Omega-3 polyunsaturated fatty acids in the oral cavity

According to the American Dental Association, diabetes increases the prevalence of oral diseases and the risk of other dental symptoms. And approximately 1/5 cases of tooth loss were reported to be related to diabetes. The top five factors of oral health in association with diabetes are gum disease, dry mouth, changes in taste, infection, slow healing and periodontal disease. The International Diabetes Federation (IDF) also recommends that periodontal disease is one of the important complications of diabetes. Current evidence has also confirmed that diabetic patients are 2 to 3 times more likely to have periodontal disease, even when their blood sugar is well-controlled. But the degree of alveolar bone destruction is negatively correlated with the control of blood sugar and the destruction maybe 4 to 11 times worse when blood sugar is uncontrolled. Severe periodontal disease will increase the blood sugar concentration in the body, not to mention that oral infection will also increase resistance to insulin. These will lead the patient into a vicious cycle of oral lesions due to diabetes. Diabetes and periodontitis are both chronic inflammatory diseases that significantly affect morbidity and represent a major health problem. However, periodontal disease is more prevalent and is associated with higher A₁C values. Studies have shown that patients with periodontal disease have a higher incidence of diabetes. Whether you have gum disease or not, adding a fish oil supplement to your diet is an easy way to meet the recommended intake of DHA and EPA omega-3s. The benefits to your teeth and gums can improve your oral health as well as offer vital prevention in the development of periodontal disease. Moreover, periodontitis is associated with macroalbuminuria, end-stage renal disease, atherosclerosis, and an increased risk of cardiovascular events. Basically, every research has pointed to an unfavorable outcome for diabetic patients. In a randomized clinical trial, it was found that the



treatment group that focused on improving the periodontal disease showed better control of blood sugar and there was a significant drop in the inflammatory response after 12 months of follow-up. Thus, it proved that diabetic patients should have routine oral examinations and cleaning. As society is aging in Taiwan, the number of diabetic patients is bound to increase, and the need for health care is becoming more important than ever. Statistically, the prevalence rate of periodontitis in Taiwan is around 29 % to 43%, with 25 % to 36% as moderate cases and 5 % to 7% as a severe cases. Diabetes will further along the progression of periodontitis and related diseases, which contribute to uncontrolled blood sugar and vascular complications in the body. For oral treatment, besides the suggestions to have a regular dental examination, good practice of teeth cleaning (once every 6 months) and brushing (following Bayer's teeth brushing technique), and good eating habits to avoid corrosive foods, it will be wise to also control the blood sugar level.

Reduce the systemic inflammatory response

Animal experiments and clinical intervention studies indicate that omega-3 fatty acids have anti-inflammatory properties and, therefore, might be useful in the management of inflammatory and autoimmune diseases. Studies on type 2 diabetes have found that chronic systemic inflammation may lead to insulin resistance because cytokines in the body will induce systemic but low-grade inflammation, which will cause the muscles and adipose tissues to become insulin resistant. When fats accumulate in the liver, it is then referred to as fatty liver and may be dysfunctional to cause more severe insulin resistance in the body. All these conditions will increase the complications of type 2 diabetes, including periodontal disease, chronic kidney diseases, etc. But proven by experiments, the supplement of omega-3 unsaturated fatty acids can reduce insulin resistance caused by systemic inflammation [9,10].

Conclusion

The American Heart Association (AHA) recommends adults take between 500 – 1,000 milligrams of omega-3 per day. However, other countries and organizations recommend different doses. The amount of ALA in omega-3 supplements can depend on the type of supplement and the manufacturer. Diabetes is a chronic disease with abnormal metabolism. Due to the relative or absolute lack of insulin in the body, or the resistance of muscles and adipose tissues to insulin, the body's ability to use the ingested starch is reduced or completely obliterated. The result is elevated blood sugar, which in turn cause mayhem in the metabolism of carbohydrates, lipids, and proteins. Muscles lose mass and are weakened in strength, resulting in the condition of sarcopenia [7,11,12]. Omega-3 fatty acids increase the oxidation of fatty acids in the liver, adipose tissues, and skeletal muscles and limit their lipid accumulation in these tissues. It also reduces the production and release of adipokines, which promote inflammation. In the skeletal muscles, it promotes protein synthesis. All these activities will help to improve the overall metabolism. It is noted that patients with poor blood sugar control have reduced salivation; thus, oral cleaning is very important, since the

bacterial growth will cause dental caries, gingivitis, periodontal disease, etc., in which periodontal disease is the most common oral complication in diabetic patients. The periodontal tissues are usually destroyed by the end products of glycation, causing swelling and bleeding of the gums. The interdental space is also expanded in the process. In some severe cases, patients may even lose their teeth. Therefore, diabetic patients should be supplemented with Omega-3 PUFA and pay attention to their oral health [13-16].

References

1. Simopoulos AP. Dietary omega-3 fatty acid deficiency and high fructose intake in the development of metabolic syndrome, brain metabolic abnormalities, and non-alcoholic fatty liver disease. *Nutrients*. 2013 Jul 26;5(8):2901-23. doi: 10.3390/nu5082901. PMID: 23896654; PMCID: PMC3775234.
2. Chen C, Yang Y, Yu X, Hu S, Shao S. Association between omega-3 fatty acids consumption and the risk of type 2 diabetes: A meta-analysis of cohort studies. *J Diabetes Investig*. 2017 Jul;8(4):480-488. doi: 10.1111/jdi.12614. Epub 2017 Feb 3. PMID: 28032469; PMCID: PMC5497038.
3. Gao H, Geng T, Huang T, Zhao Q. Fish oil supplementation and insulin sensitivity: a systematic review and meta-analysis. *Lipids Health Dis*. 2017 Jul 3;16(1):131. doi: 10.1186/s12944-017-0528-0. PMID: 28673352; PMCID: PMC5496233.
4. Azuma MM, Cardoso CBM, da Silva CC, de Oliveira PHC, Jacinto RC, Andrada AC, Cintra LTA. The use of omega-3 fatty acids in the treatment of oral diseases. *Oral Dis*. 2022 Mar;28(2):264-274. doi: 10.1111/odi.13667. Epub 2020 Oct 27. PMID: 33022782.
5. Lepretti M, Martucciello S, Burgos Aceves MA, Putti R, Lionetti L. Omega-3 Fatty Acids and Insulin Resistance: Focus on the Regulation of Mitochondria and Endoplasmic Reticulum Stress. *Nutrients*. 2018 Mar 14;10(3):350. doi: 10.3390/nu10030350. PMID: 29538286; PMCID: PMC5872768.
6. Rizza S, Tesaro M, Cardillo C, Galli A, Iantorno M, Gigli F, Sbraccia P, Federici M, Quon MJ, Lauro D. Fish oil supplementation improves endothelial function in normoglycemic offspring of patients with type 2 diabetes. *Atherosclerosis*. 2009 Oct;206(2):569-74. doi: 10.1016/j.atherosclerosis.2009.03.006. Epub 2009 Mar 19. PMID: 19394939; PMCID: PMC2772138.
7. Dupont J, Dedeyne L, Dalle S, Koppo K, Gielen E. The role of omega-3 in the prevention and treatment of sarcopenia. *Aging Clin Exp Res*. 2019 Jun;31(6):825-836. doi: 10.1007/s40520-019-01146-1. Epub 2019 Feb 19. PMID: 30784011; PMCID: PMC6583677.
8. Wong CY, Yiu KH, Li SW, Lee S, Tam S, Lau CP, Tse HF. Fish-oil supplement has neutral effects on vascular and metabolic function but improves renal function in patients with Type 2 diabetes mellitus. *Diabet Med*. 2010 Jan;27(1):54-60. doi: 10.1111/j.1464-5491.2009.02869.x. PMID: 20121889.
9. Farmer A, Montori V, Dinneen S, Clar C. Fish oil in people with type 2 diabetes mellitus. *Cochrane Database Syst Rev*. 2001;(3):CD003205. doi: 10.1002/14651858.CD003205. Update in: *Cochrane Database Syst Rev*. 2008;(1):CD003205. PMID: 11687050.
10. Jamilian M, Samimi M, Mirhosseini N, Afshar Ebrahimi F, Aghadavod E, Taghizadeh M, Asemi Z. A Randomized Double-Blinded, Placebo-Controlled Trial Investigating the Effect of Fish Oil Supplementation on Gene Expression Related to Insulin Action, Blood Lipids, and Inflammation in Gestational Diabetes Mellitus-Fish Oil Supplementation and Gestational Diabetes. *Nutrients*. 2018 Jan 31;10(2):163. doi: 10.3390/nu10020163. PMID: 29385062; PMCID: PMC5852739.
11. Okamura T, Hashimoto Y, Miki A, Kaji A, Sakai R, Iwai K, Osaka T, Ushigome E, Hamaguchi M, Yamazaki M, Fukui M. Reduced dietary omega-3 fatty acids intake is associated with sarcopenia in elderly patients with type 2 diabetes: a cross-sectional study of KAMOGAWA-DM cohort study. *J Clin Biochem Nutr*.



2020 May;66(3):233-237. doi: 10.3164/jcbs.19-85. Epub 2020 Mar 6. PMID: 32523250; PMCID: PMC7263935.

12. 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 Nov 19;106(21):2747-57. doi: 10.1161/01.cir.0000038493.65177.94. Erratum in: *Circulation*. 2003 Jan 28;107(3):512. PMID: 12438303.

13. Calder PC. Omega-3 fatty acids and inflammatory processes. *Nutrients*. 2010 Mar;2(3):355-374. doi: 10.3390/nu2030355. Epub 2010 Mar 18. PMID: 22254027; PMCID: PMC3257651.

14. ORIGIN Trial Investigators; Bosch J, Gerstein HC, Dagenais GR, Díaz R, Dyal L, Jung H, Maggiono AP, Probstfield J, Ramachandran A, Riddle MC, Rydén LE, Yusuf S. n-3 fatty acids and cardiovascular outcomes in patients with dysglycemia. *N Engl J Med*. 2012 Jul 26;367(4):309-18. doi: 10.1056/NEJMoa1203859. Epub 2012 Jun 11. PMID: 22686415.

15. Calder PC, Yaqoob P. Understanding omega-3 polyunsaturated fatty acids. *Postgrad Med*. 2009 Nov;121(6):148-57. doi: 10.3810/pgm.2009.11.2083. PMID: 19940425.

16. Gioxari A, Kaliora AC, Marantidou F, Panagiotakos DP. Intake of ω -3 polyunsaturated fatty acids in patients with rheumatoid arthritis: A systematic review and meta-analysis. *Nutrition*. 2018 Jan;45:114-124.e4. doi: 10.1016/j.nut.2017.06.023. Epub 2017 Jul 8. PMID: 28965775.

Discover a bigger Impact and Visibility of your article publication with Peertechz Publications

Highlights

- ❖ Signatory publisher of ORCID
- ❖ Signatory Publisher of DORA (San Francisco Declaration on Research Assessment)
- ❖ Articles archived in worlds' renowned service providers such as Portico, CNKI, AGRIS, TDNet, Base (Bielefeld University Library), CrossRef, Scilit, J-Gate etc.
- ❖ Journals indexed in ICMJE, SHERPA/ROMEO, Google Scholar etc.
- ❖ OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting)
- ❖ Dedicated Editorial Board for every journal
- ❖ Accurate and rapid peer-review process
- ❖ Increased citations of published articles through promotions
- ❖ Reduced timeline for article publication

Submit your articles and experience a new surge in publication services (<https://www.peertechz.com/submission>).

Peertechz journals wishes everlasting success in your every endeavours.