

Dietary Supplementation/Diet Therapy Supporting Eyesight/Eye Health in Neurological Disorders

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Submission: October 02, 2024; **Published:** October 15, 2024

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Abstract

Neurological disorders closely related to increase risk of disturbances of eyesight and vision, affecting neural and muscular functions crucial for visual control and movement. Diseases, such as multiple sclerosis, stroke, and hypertension, alongside aging and certain cancers, can lead to partial or complete vision loss by impairing optic nerve function. Diagnosis of eye disorders arising from neurological conditions involves thorough medical history, eye examinations, and medical imaging. Early detection of arising problems with vision is crucial for early therapeutic intervention, ranging from pharmacotherapy to surgical interventions. Moreover, nutrition plays a vital role in managing eye health and neurological function which is particularly important in older individuals who do to other reasons may have inadequate intake of essential nutrients, and therefore increasing the risk of ocular diseases. Malnutrition, as well as deficiencies in micronutrients like vitamin D and antioxidants such as zinc and vitamins C and E may contribute to inflammatory eye conditions and age-related macular degeneration. Omega-3 fatty acids, abundant in fish, support neurological and ocular function, while inadequate intake increases the risk of diabetic retinopathy and dry eye syndrome. A balanced diet, rich in fruits, vegetables, and omega-3-rich foods like fatty fish, is essential for preventing and managing neurological eye disorders. Furthermore, specific foods like broccoli, saffron, and walnuts offer additional benefits due to their antioxidant and anti-inflammatory properties, protecting against oxidative stress and inflammation in ocular tissues. Dietary interventions, including the Mediterranean-style diet, combined with appropriate supplementation, can significantly reduce the risk of sight-threatening diseases. However, individual dietary components like curcumin from turmeric and green tea have shown promise in managing diabetic retinopathy. Overall, adopting a holistic approach that emphasizes nutrition alongside medical treatment is vital for preserving eye health and preventing vision impairment in individuals with neurological disorders.

Keywords: Dietary Interventions; Neurological Eye Disorders; Pupillary Testing; Mediterranean-Style Diet; Ophthalmologists

Abbreviations: OCT: Optical Coherence Tomography; AMD: Age-Related Macular Degeneration; MPOD: Macular Pigment Optical Density; ALA: α -Linolenic Acid

Introduction

Neurological disorders, including multiple sclerosis, stroke, hypertension, progressive aging and some cancers, can have a significant impact on eyesight and vision, particularly by affecting the neural and muscular function, which is essential to control vision and movement. In addition, certain neurological diseases can impair the function of the optic nerve, leading to gradual, partial or complete vision loss. Although alerted eye vision characterized by inflammation and progressive blindness seem to be often observed in older individuals, aged over 55 years, other chronic and autoimmune pathologies have been linked with the risk of eyesight disturbance. Some of the most common include

Optic neuritis, an Inflammation of the optic nerve, often occurring in multiple sclerosis patients, Ischemic optic neuropathy, a vision loss due to restricted or low blood flow to the optic nerve, due to development of pituitary or brain tumors, and/or increased pressure of cerebrospinal fluid in the head. In addition, alerted eye function may occur in certain patients after stroke, which can lead to loss of peripheral visual field, nystagmus, or eye misalignment [1].

Neurological eye disorders can be diagnosed through a medical history, reflecting use of medications as well as general and ocular health. If the potential cause is suspected, the detailed

eye examination, including assessment of visual acuity, color vision, pupillary function, visual fields, contrast sensitivity, and performing a detailed fundus is recommended. In addition, the evaluation of eye movements (e.g., ductions, versions, saccades, pursuits, eyelid positioning and function, pupillary testing) along with psychoneurological assessment assessing the patient's mental status, motor reflexes, coordination/gait, and general sensory receptors through medical imaging, such as MRI, CT scans, and optical coherence tomography (OCT) can help to visualize the brain, optic nerve, and other structures. In some cases, also electrophysiological testing of optical electrophysiology can be use full to examine the function of the cornea and retina [2].

Detailed and early diagnosis is crucial to determine the underlying cause of eye pathology and prescribe appropriately targeted treatment options. Depending on the diagnosis, the proposed treatment strategies can vary from pharmacotherapy, usually with steroids and other immunosuppressants applied in case inflammatory conditions (e.g., optic neuritis, autoimmune optic neuropathy, and chronic relapsing inflammatory optic neuropathy). For some patients the surgical treatment may be necessary for optic nerve disorders, eye muscle problems, or to relieve pressure on the brain while restoring eye alignment. Nevertheless, primarily, the underlying causes of altered visions should be addressed [2].

Botox Injections May Help Reduce Muscle Spasms in Patients with Altered Vision Developed due to Neurological Disease

Botox injections (OnabotulinumtoxinA/ can indeed help reduce muscle spasms in patients with altered vision. These injections are commonly used to treat various eye conditions caused by muscle or nerve problems, providing relief from symptoms like uncontrolled blinking, twitching, and spasming of the eyelids. Interestingly, Botox has been FDA-approved as treatment for blepharospasm and hemifacial spasm, where patients experience involuntary eyelid movements or facial twitching. By blocking nerve activity when injected into muscles, Botox temporarily reduces muscle activity, alleviating the symptoms associated with these conditions and helping patients manage their vision-related issues [3].

The Role of Nutrition in Management of Neurological Disorders Associated with Impaired Vision and Eye Diseases

Nutrition and intake of recommended amounts of nutrients have a crucial role in the management of neurological disorders associated with impaired vision and eye diseases. This have been especially reported in older individuals, who seem to have the inadequate intakes of micronutrients, which are essential for maintaining ocular health and preventing e.g., night blindness,

dry eyes, and retinal degeneration [4]. For example, vitamin D deficiency can increase risk of uveitis, an inflammation of the uvea, the middle layer of the eye containing the iris, ciliary body, and choroid (Duplechain et al., 2023), as well as autoimmune eye diseases, such as scleritis (Glover et al., 2021). Similarly, low intake of key antioxidants, like zinc, vitamin C and E, as well as lutein and zeaxanthin has been linked with reduced antioxidant protection and increased risk of oxidative damage caused by free radicals and retinal hemorrhages, night blindness and age-related macular degeneration (AMD) [4]. Therefore, incorporating a variety of fruits and vegetables rich in antioxidants, such as vitamin C, vitamin E, and beta-carotene, into the everyday diet is essential for promoting eye health, as these antioxidants play a crucial role in combating oxidative stress within the eye, which can contribute to the development of cataracts and AMD. By reducing oxidative damage to ocular tissues, these nutrients help protect the lens of the eye and the macula, ultimately reducing the risk of cataracts and AMD. Daily intake of 6-20 mg of lutein and zeaxanthin through regular consumption of dark leafy greens (e.g., spinach and kale), as well as egg yolks, pistachios, Brussel sprouts, broccoli, asparagus and carrots can support macular health and absorption of e.g., polyunsaturated fatty acids, including omega-3, as well as reduce the risk of AMD, by serving as defense against oxidative damage and light [4].

Insufficient intake of omega-3 fatty acids, particularly EPA and DHA, as a vital for neurological development nutrients, also including appropriate eye development and function. DHA is highly concentrated in the retina and may help support ocular function. Omega-3 intake can help relieve symptoms of dry eye syndrome and reduce the risk of diabetic retinopathy. To ensure adequate intake of omega-3, a regular consumption of two portions of fish weekly, of which one includes fatty fish rich in EPA and DHA, like salmon, herring, sardines and mackerel is essential for appropriate development of neurological and immune function and may protect against AMD. If the advised intake of 1.6g (males) and 1.1g (females) of omega-3 cannot be achieved through diet, the supplementation is highly recommended [4].

Nutritional blindness can also be a consequence of an eating disorder known as avoidant-restrictive food intake disorder characterized by limited consumption or the avoidance of certain foods, leading to the persistent failure to meet the individual's nutritional and/or energy needs has been linked with sight loss in both children and adults (Sharansky et al., 2024).

Dietary recommendations for improving eyesight and reducing risk of alerted eye function in neurological disorders

A balanced, preferably a plant-based diet rich in eye-healthy nutrients like vitamins, minerals, antioxidants, and fatty acids is essential for preventing and managing neurological disorders

associated with vision impairment and eye diseases [4]. Diets that are healthier overall (reduced sugar, alcohol, and fats, and increased fruits, vegetables, and fish) have been linked to a reduced risk of any sight loss especially that resultant from aging. In addition, greater adherence to “Mediterranean-style diet” as example of diet which is predominantly plant-based and high in vegetables, fruit, nuts, legumes, and extra-virgin olive oil, with moderate to high amounts of fish was able to reduce risk for advanced AMD [5]. In addition, combining a low glycemic index diet with higher omega-3 intake were associated with the greatest reduction in risk for prevalent drusen and advanced AMD [6].

Recommended Foods with Benefits for Eye Health

An interesting approach connecting dietary supplementations and dietary interventions, is increasing consumption of foods/extract of foods which have been proven to be beneficial for supporting eye health and reducing progression of ocular diseases. Among proposed nutraceutical supplements based on natural food extracts, broccoli, saffron and walnuts being the most common, owing their high levels of antioxidants [7].

Broccoli

A high levels of nutritional constituents such as lutein/zeaxanthin, make the broccoli as plant food recommended for the fight against age-related chronic inflammatory and/or neurodegenerative disorders, as well as to improve eye and vision care. A pilot intervention conducted on the group of 14 volunteers, who were given either a portion of 375 g/day of broccoli (equivalent to 10 g of lutein) 4 weeks had improved subjective criteria on visual function during activities of daily living, as well as to a significant increment in the Macular pigment optical density (MPOD) in the retinographies, compared to individuals who were not on broccoli-based diet. Importantly, the volunteers were given a strict cooking instruction how to prepare broccoli meals to avoid loss of the antioxidants and other bioactivities in broccoli, [8].

Saffron:

The beneficial effects of saffron attributed to the presence of more than 100 bioactive, including crocin isomers, zeaxanthin, lycopene and vitamin B12, have been demonstrated beneficial - neuroprotective effect in management of neurodegenerative diseases, such as Alzheimer's and Parkinson's, as well as in conditions affecting eye. In AMD, saffron can improve visual function by reversing the damage to photoreceptors and bipolar cells caused by oxidative stress. Interestingly, a daily supplementation with 30mg of saffron after 6 months significantly improved retinal changes observed with optical coherence tomography and electroretinogram in patients with both dry and wet AMD [9]. Similarly, supplementation of 15mg crocin tablets after 3 months can reduce insulin resistance in pre-diabetic

patients, while also decreasing macular thickness improving visual acuity in patients with diabetic macular edema [10].

Walnuts:

Walnuts, as a rich source of various nutritional components (e.g., polyphenols, phytosterols, γ -tocopherol, and essential omega-3 fatty acid, known as α -linolenic acid (ALA), minerals) which regular consumption have been shown to protect against many chronic diseases, including those affecting the optic nerve, the retina and the ocular microcirculation. Regular consumption of walnuts was associated with better cognitive performance and memory, learning, motor coordination. A walnut-enriched diet is proven, with protective action against the events related to oxidative stress and inflammation present in different chronic diseases, including brain disorders and different eye diseases, such as glaucoma, DR and age-AMD as well as chronic pathologies with a degenerative character for the ocular structures, which share common pathophysiological mechanisms, characterized by the presence of events related to oxidative stress and inflammation.

In Addition, the main polyphenols of walnuts, ellagitannins and their metabolites (urolithins), have beneficial properties against the oxidation and inflammation pathways, in addition to positively influencing the intestinal microbiome. Similarly, walnut Phytosterols in addition to antioxidant properties are powerful free radical scavengers, acting to reduce pro-inflammatory eicosanoids, and then mitigating the inflammatory response and improve neuroprotective capacity in brain function, and also in eye, especially in the retina and the optic nerve [8]. Although individual vitamin or antioxidant intake was not found to be protective against AMD, a higher combined antioxidant intake (500 mg vitamin C, 400 IU vitamin E, 80mg zinc, and 15 mg beta-carotene) was found to be linked to a lower risk of sight loss in individuals aged between 55 and 80 years [11]. Examples of foods with additional health benefits for eyesight

Curcumin:

Curcumin as key bioactive compound known of potent antioxidant and anti-inflammatory properties obtained from the turmeric plant (*Curcuma longa*) was proposed in the management of diabetic radiculopathy, mostly through reduced production of reactive oxygen species, and lowering inflammation. A 4 week long intervention with two doses of curcumin a day (each 100mg of curcumin) in 38 human significantly reduced edema and improved visual acuity, thus suggesting potential of curcumin in the management of diabetic microangiopathy and retinopathy (Steigerwalt et al., 2012).

Green Tea:

Green tea (*Camellia sinensis*) is as a great source of various flavonoids with antihyperglycemic, antioxidant and anti-inflammatory properties have shown potential in amelioration of

glutamate toxicity mediated by Müller cells and retinal pigment epithelial cells in the retina in-vitro. Interestingly, in a small case control study, weekly consumption of Chinese green tea for at least one year in diabetic patients was associated with about 50% lower risk of DR (Ma et al., 2015).

Summary

Knowledge on diet therapy in the prevention of chronic eye diseases affecting vision and eye health is emerging, due to increased prevalence of sight-threatening diseases resultant from chronic inflammatory conditions or long-use of certain medications. Ophthalmologists, researchers, and policymakers, have to pay special attention to the diet and lifestyle patterns of the population, to identify people at high risk of developing eye diseases, especially those related to progressive aging, diabetes, tumor or stroke, who can be especially vulnerable to ocular diseases progression. Given an increased need for development of preventive measures to avoid visual impairment and blindness, the use of appropriately targeted dietary advice, including the Med Diet along with appropriate oral supplements with vitamins, carotenoids and omega-3 fatty acids will allow to improve eye and vision care [12,13].

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DOI: [10.19080/JOJO.2024.10.555819](https://doi.org/10.19080/JOJO.2024.10.555819)

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