

Nutrition and the Health of the Eye: Not Just B-Carotene

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The eye is constantly subjected to multiple stress factors and subsequent damage from the external environment. The first elements of stress are directly related to its function: the eye is, in fact, constantly exposed to light and to solar radiation. To perform its function, this organ needs specific macronutrients and micronutrients, which allow it to regenerate the outer segments of the photoreceptor cells, particular sensory cells placed on the retina. The photoreceptor cells are divided into cones (responsible for diurnal vision) and rods (specialized for twilight/night vision).

Some additional stress factors of the eye include prolonged exposure to environmental light (especially short-wavelength light), smoking, environmental pollution, dust and wind, physical and emotional stress. These stressors add to forms of age-related degeneration of the eye, such as age-related macular degeneration (AMD), an age-related disease that affects the central part of the retina (macula). AMD is a major cause of visual loss. This frequent pathology contributes significantly to the ocular disability of older people. Important AMD risk factors are: age, family history, female sex, Caucasian race, smoking, arterial hypertension, excessive exposure to sunlight, central obesity and a diet rich in fat, cholesterol and simple sugars [1,2].

Free radicals and the health of the eye

The most important cause of ocular damage is oxidative stress caused by free radicals, highly unstable molecules that can damage the structures they come in contact with. These molecules can be formed physiologically during metabolic mechanisms or, in some cases, as the consequence of exposure to toxic elements. Oxygen is the molecule that most often determines the formation of free radicals such as hydrogen peroxide, hydroxyl radical, and peroxyxynitrite.

The eye is constantly exposed to sunlight and artificial lighting. Exogenous sources of reactive oxygen species (ROS) such as UV rays, visible light, ionizing radiation and environmental toxins contribute to oxidative damage. A long-term exposure of the eye to the above-mentioned agents increases the impact of their pathological consequences on this organ. In fact, in time all the ocular structures -from the pre-corneal film to the retina- are exposed to oxidative stress and, as a consequence, the antioxidant defence mechanisms present in each tissue are important for the overall protection of the eye from degenerative diseases.

Metabolic syndrome, through the excessive production of free radicals, also plays a fundamental role in the development of retinopathies. Oxidative damage is, in fact, considered to be one of the main mechanisms determining retinal endothelial dysfunction.

Many nutritional compounds have been identified as possible protective factors of the retina. In particular, there is increasing evidence that specific macro and micronutrients (especially vitamins A, C, D, and E), carotenoid pigments (e.g. lutein and zeaxanthin) and specific trace elements (e.g. Zinc and Copper) can help prevent or delay the onset of many eye problems typical of old age [3,4]. Keeping this in mind, the following points should be remembered:

- Lutein and Zeaxanthin are two carotenoids, which normally accumulate in the centre of the retina, acting as natural antioxidants. Some foods which are richest in these elements are: cabbage, spinach, chard, black cabbage, yellow squash, broccoli, zucchini, egg yolk, corn. Evidence from clinical trials show protection of retina in early AMD [5] from various antioxidants and nicotinamide.
- Polyunsaturated fatty acids, especially omega-3 (EPA and DHA), are associated with a reduction in the risk of developing maculopathies. The foods richest in EPA and DHA are: wild salmon, fresh tuna, mackerel, swordfish, rainbow trout, anchovies, sardines, and cod;
- Vitamin C is contained especially in kiwi, yellow and red peppers, broccoli, saffron, citrus fruits (e.g. oranges, grapefruit, mandarins), summer and winter melons, strawberries, apricots and peaches;
- Vitamin E is present in extra virgin olive oil and in oleaginous fruits (e.g. walnuts, hazelnuts, almonds, and pine nuts);
- Vitamin D can be obtained especially from wild salmon, tuna, halibut, egg yolk;
- Beta-Carotene (provitamin A) is contained in high amounts in tomatoes, yellow and red peppers, carrots, mango, apricots, peaches, melon, potatoes, watermelon, and pumpkin. Vitamin A is present in egg yolk, butter, blue fish, fresh tuna, and dairy products in general;
- Zinc and Copper, according to the AREDS study (Age-related Eye Disease Study), play an important role in reducing the development of maculopathy. Foods with a higher zinc content are: seasoned cheeses, lean beef, lentils, lupin beans, animal liver (beef and pork). On the other hand, some foods rich in copper are: hazelnuts, chocolate with minimum 70% cocoa, soya bean, lentils, and buckwheat [6,7].

Metabolic syndrome and the health of the eye

Cardiometabolic diseases such as diabetes, overweight, obesity and hypertension, if not adequately treated, can determine adverse effects also on the retina. In fact, studies have recently observed that the metabolic syndrome is associated with negative health outcomes not only on heart, liver, pancreas and lungs but also determines various pathological conditions of the eye, including retinopathy, glaucoma and cataracts.

In particular, several studies indicate that hyperglycaemia and hypertension are two important risk factors associated with the onset and progression of retinopathy. More specifically, hyperglycaemia and chronic hypertension can cause osmotic disorders in the retinal capillaries with consequent increase of intraocular pressure. In addition, hyperglycaemia causes non-enzymatic glycation of proteins, predisposing the retina and the crystalline lens to damage.

An Italian study conducted in 2015 by Liccardo, *et al.* found evidence of a correlation between excess weight and retinal damage in the paediatric population. The study, in fact, documented an improvement in retinopathies subsequent to the loss of body fat [8,9].

A nutritional approach in the treatment of Metabolic Syndrome

The main priority in patients with Metabolic Syndrome is undoubtedly weight reduction. The American Heart Association (AHA), the American College of Cardiology (ACC) and the Obesity Society in collaboration with the National Heart, Lung, and Blood Institute (NHLBI) have released new practice guidelines for the treatment of obesity. According to these guidelines, overweight and obese adults with risk factors for diseases affecting the cardiovascular system should be informed that a weight loss of 3 - 5% of their body weight would already result in important health benefits. Furthermore, a weight loss greater than 5% of their body weight would improve hypertension, reduce blood lipids, and reduce the need to take medications for blood pressure, blood sugar and lipids.

A diet useful in obtaining weight loss and reduction of hypertension can be achieved through the reduced intake of:

- Animal fats and hydrogenated fats (contained for example in butter, margarine, lard, salami, sausage, and offal);
- Simple sugars and packaged confectionery products;
- Sugary drinks such as fruit juices with added sugars and carbonated soft drinks;
- Cooking salt.

It is a good rule to reduce the amount of salt added to food during and after cooking and limit the consumption of foods that contain large quantities of salt (e.g. some canned/frozen foods, nuts and meat extracts, soy sauces). Instead, foods can be easily flavoured using spices and herbs that are rich in micronutrients. It is also important to use healthy cooking methods. In fact, food can be steamed, microwaved, grilled, or pressure cooked, as opposed to being stir fried or deep fried, all methods which increase the food's content of fat and sodium. A good practice is to add extra virgin olive oil at the end of food preparation, so as to not damage the vitamin E and polyunsaturated fatty acids through exposure to high temperatures [10,11].

It should be remembered that the importance of the Metabolic Syndrome in affecting the health of the eye is still underestimated. Only today are we becoming aware of the importance of this correlation, both in epidemiological and clinical terms. Metabolic Syndrome leads to a strongly altered metabolism. It increases the incidence and significantly worsens the prognosis of cardiovascular disease, strokes, eye diseases, type 2 diabetes mellitus, non-alcoholic fatty liver disease and tumours. In particular, several studies indicate that central obesity, hyperglycaemia, hypertension and oxidative stress – all conditions of the metabolic syndrome- represent risk factors associated with the onset and progression of retinopathy and cataracts.

In conclusion, it is important to remember that a healthy and balanced diet and avoiding a sedentary lifestyle, cigarette smoking and alcohol consumption are all elements that bring significant benefits to the health and well-being of our eyes [12].

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