

# Ocular and systemic health

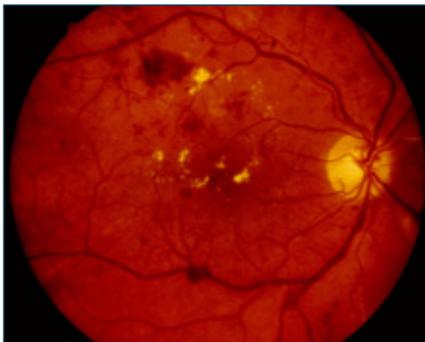
## The role of exercise and nutrition

**O**ne can be fit and unhealthy and one can be unfit and healthy but ideally one should be both fit and healthy. A healthy person is more likely to have healthy eyes, as Duke-Elder once stated, "Glaucoma is a sick eye in a sick body"<sup>1</sup>.



The benefits of physical exercise (not necessarily sport) and good nutrition have been proven by ocular and systemic studies of glaucoma, cataract, age-related macular degeneration (AMD), diabetes,

» Figure 1  
Pre-proliferative retinopathy



» Figure 2  
Atherosclerosis



» Figure 3  
Hypertensive retinopathy



atherosclerosis, hypertension, arteriosclerosis and coronary heart disease<sup>2</sup>. This article concentrates on the two-pronged approach of exercise and good nutrition, which can help prevent, stabilise or even reverse these disorders.

Good nutrition is essential and has three main functions – it builds and repairs body tissues, regulates metabolism and supplies energy. In optimal nutrition, foods or nutrients actively promote health, while physical inactivity is a known risk factor for cardiovascular disease.

A study of sedentary postal workers and inactive bus drivers revealed twice the coronary heart disease prevalence when compared to the more active conductors in double-decker buses and physically active postal workers<sup>3</sup>. Regular exercise increases insulin sensitivity, reduces plasma triglycerides and low density 'bad' cholesterol lipid levels (LDL), while raising the high density 'good' cholesterol lipid levels (HDL). Exercise also controls blood pressure by helping to protect capillaries from damage and, as an added bonus, is an anti-depressant.

In general, a regime of a minimum of 30 minutes exercising five times a week, in conjunction with good nutrition, is sufficient to maintain good health and fitness and reduce the chances of developing about 20 illnesses associated with sedentary lifestyles. Obesity, where the body is both unfit and unhealthy, has now reached epidemic proportions. It is costly for governments and can be a health disaster for nations. It accelerates systemic diseases affecting the cardiovascular, respiratory, gastrointestinal, uro-genital and musculo-skeletal systems. It is also a known risk factor for cancer<sup>4</sup>.

Weight loss may be all that is needed to control Type 2 diabetes. It can be achieved with regular aerobic exercise, which reduces blood sugar and insulin levels. The more fat calories a person burns, the greater their insulin sensitivity. Ocularly, the consequences of obesity can lead to diabetic retinopathy (Figure 1), raised IOP, cataract, floppy eyelid syndrome, papilloedema, pseudotumour cerebri, non-arteritic ophthalmic ischaemic neuropathy (NAOIN) and AMD. Regular exercise and good nutrition may prevent, stabilise or reverse ocular systemic diseases (see later).

### Oxidation and free radicals

Free radicals are reactive molecules, created by natural metabolic processes which can damage healthy cells and tissues by oxidation – a process causing 'oxidative stress'. The body has a natural endogenous antioxidant system, with enzymes like catalase and glutathione peroxidase, both of which are zinc dependent, protecting it against damage. However, it may need boosting on occasions, especially as we grow older (a 50-year old has only half the antioxidants of a child).

Oxidative stress occurs when there are too many damaging free radicals from poor diet, smoking (one puff of a cigarette releases over 1,000 free radicals), pollution, sunlight and ageing. It may seem paradoxical but exercise itself produces free radicals when the body does not have enough antioxidants to quench their harmful effects. This is why we need extra antioxidants in our diet.

Oxidative stress contributes to a number of systemic diseases like atherosclerosis, coronary heart disease and hypertension, as well as some cancers, respiratory and brain diseases, cystic fibrosis and miscellaneous conditions such as malaria, rheumatoid arthritis and mitochondrial disease. It also contributes to ocular disorders like cataract, AMD, hypertensive retinopathy and retinal vein and artery occlusion.

### Systemic disorders

Atherosclerotic vascular disease is caused by high 'bad' LDL levels. LDL promotes the deposition of cholesterol on the walls of the arterioles, called atherosclerosis (Figure 2). Smoking, hypertension, obesity, physical inactivity and poor diet contribute to the condition, which can lead to fatal coronary heart disease. However, this can be remedied by increasing the 'good' LDL levels with regular 30-minute aerobic exercise four times weekly and by taking folic acid supplements.

Patients with hypertension should be advised to seek smoking cessation support from their GP, reduce their alcohol intake and body weight, eat more 'good' nutrients, have a low intake of fatty foods and undertake a regular exercise programme, such as brisk walking for 30 to 45 minutes a day four times a week. This can help reduce the risk of developing hypertensive retinopathy (Figure 3).

Coronary heart disease is a leading killer in many parts of the world, in which atherosclerosis is a major factor. To reduce the risks, a well balanced diet is important. This would include monounsaturated fatty acids – the 'good' fats which lower the 'bad' LDL levels. Examples of such foods are peanuts, peanut oil, almonds, cashew nuts,

pecan nuts, olives, olive oil and avocados. Omega-3 fats (see later) have been shown to reduce the incidence of cardiovascular disease. Diet, however, does not affect 'good' HDL levels as significantly as regular aerobic exercise.

There is an inverse relationship between heart disease mortality and intake of fruit and vegetables. The World Health Organisation recommends five portions per day or 400g<sup>5</sup>. The major risk factors are elevated plasma levels of cholesterol, high blood pressure, smoking, stress, obesity and a sedentary lifestyle<sup>6</sup>. An independent risk factor is raised levels of homocysteine in the body, which can be reduced with folic acid supplements or dietary intervention. Once again, regular exercise is highly recommended.

## Ocular disorders related to exercise and nutrition

### Cataract

Cataract is related to poor health and is associated with, for example, smoking, cardiovascular disease, diabetes, poor nutrition, obesity, dehydration and the phototoxic effects of sunlight<sup>7</sup>. The lens has 20 times the concentration of vitamin C than is found in the blood<sup>8</sup>. There is also a correlation between vitamin E and cataract with a reduced risk at high concentrations.

To halt or delay the progression of age-related cataract, it is advisable to:

- Wear sunglasses
- Take supplements of beta-carotene and vitamins C and E, which reduce the risk associated with a diet lacking in fruit and vegetables
- Include minerals in the diet, such as zinc and selenium
- Exercise regularly

### AMD

The two main theories regarding the cause of AMD are both oxidative, one largely related to diet and light protection and the other vascular<sup>9</sup>. However, one theory does not preclude the other.

AMD is the leading cause of bilateral vision loss in the developed world, and occurs in both 'wet' and 'dry' forms (Figure 4). There are about 20 potential and established risk factors for AMD<sup>10</sup>. At least a dozen of these are modifiable, i.e. hypertension, cardiovascular disease, smoking, excessive alcohol consumption, high cholesterol, low serum zinc, Type 2 diabetes and sunlight exposure (which reduces glutathione in the retina). They are also related to lack of exercise and poor nutrition. The macula is particularly sensitive to free radical damage because of exposure to the 'blue light hazard'. To prevent, stabilise or reverse AMD, high levels of antioxidants are essential to combat free radical damage, in conjunction with exercise.

The retina is highly active metabolically, having a higher blood flow than other

tissues, and AMD is associated with narrowed arteries and poorly functioning capillaries. Both exercise and good nutrition increase blood flow.

### Glaucoma

Two primary responses occur in the eye as a result of exercise. Firstly, intraocular pressure (IOP) decreases by about 4mmHg immediately with vigorous exercise and, more importantly, in the long-term with regular exercise. This is probably due to osmotic changes in the retinal and uveal vasculature. Secondly, there is an increase in blood flow.

Prolonged static exercise (exercises inducing the valsalva manoeuvre and where the legs are raised above the head) should be avoided as they can increase the IOP.

Glaucomatous eyes are sensitive to damage from a lack of nutrients and free radical formation, in part determined by lifestyle. Therefore, in addition to an exercise programme, a diet rich in good nutrients can be beneficial and may possibly protect the retinal ganglion cells from further damage.

Patients with pigment dispersion syndrome should be advised that strenuous activity releases iris pigment into the trabecular meshwork and predisposes them to raised IOP and glaucoma, despite having an open angle.

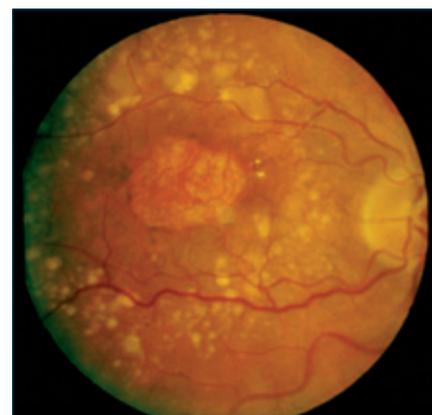
### Central retinal artery/vein occlusion

The risks of either type of occlusion are associated with high cholesterol, heart disease, arteriosclerosis, hypertension, glaucoma and diabetes. Risks of either central retinal venous or arterial occlusion (Figure 5), decrease with increased levels of physical activity. To prevent occlusions, a good blood flow is essential – so eating foods which increase blood flow and those with high antioxidant values is necessary (see later).

### Micronutrients and antioxidation

In each macronutrient (protein, carbohydrate and fat) there are the micronutrients, such as vitamins, minerals, phytochemicals (aka polyphenols), which are either carotenoids (oil-soluble) or bioflavonoids (water-soluble) and enzymes. They have antioxidant properties and protect against free radicals, but they have to work synergistically, e.g. beta-carotene needs zinc to form vitamin A, whereas an excess of iron can exacerbate a zinc deficiency. As the body's antioxidants reduce with age, their deficiency can disable the normal antioxidant system.

A balance of vitamins and minerals are beneficial for health. This is especially the case when aerobic exercise is undertaken, as they are involved in the repair and maintenance of cells and tissues and the transport of essential oxygen to the muscles. Certain vitamins are crucial for processing carbohydrates and fats to



» Figure 4  
Wet and dry AMD

release energy. The recommended amounts of vitamins and minerals (aka trace elements) depend on the individual's age, gender and lifestyle. Any shortfall in the diet can be tackled with supplements.

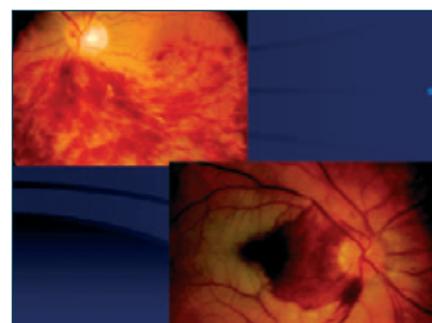
### Vitamins

Vitamin A is an immune booster and an anti-viral. It is available in milk, cheese and butter as alpha-carotene and as vitamin A in liver and egg yolk. Vitamin B complex works to convert food to energy. When the energy intake is increased by diet, the body may then need extra vitamins B1, B12 and folic acid, together with iron and vitamin C. These particular micronutrients are used in the formation of red blood cells, which transport oxygen to the muscles. Vitamin B complex is available in cereals, bread, eggs, liver, fish, wheatgerm, bananas, meat, yeast, oranges, lentils and beans.

Vitamin C promotes healthy bones and tissues, improves blood flow and has anti-viral, anti-bacterial and anti-fungal properties. It is found in citrus and soft fruits, juice and vegetables. It is not stored in the body. Vitamin E is vital to the formation and normal function of red blood cells and muscles. It improves blood flow and is can boost the body's immune system. It is found in vegetable oils, nuts, eggs, fruit and fish.

A word of caution – all vitamins have their 'robbers', e.g. coffee robs the vitamin B complex of its benefits.

» Figure 5  
Retinal venous occlusion (left)  
and retinal arterial occlusion



Food	Form/preparation	L&Z (mcg/100g)
Kale	Raw	39,550
Kale	Cooked	15,798
Spinach	Raw	11,938
Turnip greens	Cooked	8,440
Collard greens	Cooked	8,091
Spinach	Cooked	7,043
Spinach	Souffle, cooked, frozen	2,727
Lettuce	Cos or romaine, raw	2,635
Broccoli	Raw	2,445
Broccoli	Cooked	2,226
Squash	Zucchini, inc. skin, raw	2,125
Corn	Sweet, tallow, cooked	1,800
Brussel sprouts	Raw	1,590
Corn	Cornmeal, de-germed, yellow	1,355
Peas	Green, canned, pack	1,350
Brussel sprouts	Cooked	1,290

» Table 1  
Foods high in lutein/zeaxanthin<sup>15</sup>

## Minerals

Minerals facilitate antioxidant enzymes in the body. Zinc can boost the body's immune system and is an anti-viral. It is a constituent of many enzymes and is found in high concentrations in the choroid and retina. Some sources of zinc are red meat, cereals, pumpkin seeds and seafood. Selenium also boosts the immune system, and is available in nuts, particularly Brazil nuts, liver and seafood. Manganese is found in tea, cereals, pulses, blackberries, raspberries, leafy vegetables and pineapples. It helps form healthy bones, cartilage and nerves. It also activates more than 20 enzymes, including an antioxidant system, and stabilises blood sugar levels. All 'seed' foods are rich in zinc and manganese.

## Carotenoids

Sources of lutein and zeaxanthin include kale, cooked spinach, red pepper, corn and broccoli (Table 1). They are the only carotenoids found in both the macula and lens. Lower macular pigment density (MPD) is found in eyes with AMD. The MPD can be increased with a dietary intake of lutein and zeaxanthin, which correlates with improvements in visual function<sup>11</sup>. These carotenoids specifically absorb 'blue light', reducing the risk of free radical damage, and reduce the risk of AMD by 25-30% in high risk groups. There have been claims that they also protect against diabetic retinopathy, retinal occlusions, cataract and glaucoma<sup>12</sup>. It is also claimed that they protect against systemic disorders such as colon, lung and breast cancers, heart disease and high LDL cholesterol levels<sup>13</sup>.

Lycopene is a powerful antioxidant and has anti-cancer properties. Sources are tomato juice, tomatoes, pink grapefruit and red fruits. Alpha-carotene is a more potent antioxidant than beta-carotene and is available in milk, cheese, butter, carrots and pumpkin. Beta-carotene (pro-vitamin A) boosts the body's immune system and

is an anti-viral. Sources are dried apricots, peaches, carrots, cooked spinach, kale, canteloupe, sweet potatoes and pink grapefruit. Smokers should not take beta-carotene in large doses as it can increase the risk of lung cancer<sup>14</sup>.

## Bioflavonoids

The antioxidant activities of bioflavonoids can complement, extend and synergise the antioxidant activities of vitamins A, C, E and carotenoids. They make up two-thirds of the polyphenols in the diet and there are eight major types. Some of the more familiar types are flavonols, flavonoids and catechins. They can be found in oranges, red grapes, bilberries, tea, soy and onions. Generally, fruit and vegetable sources, and the brightest coloured, are rich in bioflavonoids. The most common bioflavonoid in the diet is quercetin, which is found in tea, grapes, apples and onions.

Foods which supply a large variety of antioxidants are: beans, broccoli, spinach, blueberries, oranges, pumpkin, tomatoes, oats, walnuts, salmon, turkey, yoghurt, soy (which also improves blood flow) and tea (green tea especially). All these foods measure high on their oxygen radical absorbance content (ORAC), as do prunes, beetroot, aubergines and strawberries.

## Enzymes

Foods which contain the enzymes peroxidase and catalase, the quenchers of free radicals, include apples, grapes, mangoes, mushrooms and sweet corn.

## Increased blood flow

All the ocular conditions described, except cataract, are directly associated with poor blood flow. Nutrients which are good for blood flow are, therefore, a welcome addition to the diet. Some examples are ginkgo biloba, L-Arginine (found in nuts, sunflower seeds, raisins, brown rice and chocolate), folic acid (vitamin B9), and the essential fatty acids like omega-3 and

omega-6. The omega-3 fats are available in oily fish like salmon, trout and tuna and in certain seeds (see below) and are essential to retinal function. Omega-3 fatty acids require vitamin E and other antioxidants to be effective against AMD. To replace oily fish, vegetarians can take a mix of sesame and sunflower seeds (for omega-3), flaxseeds and pumpkin seeds (for both omega-3 and omega-6). A deficiency of omega-3 can cause dry eye.

## Exercise

Exercise reduces cholesterol, blood sugar and insulin levels. Exercising regularly counteracts, delays and/or diminishes the detrimental effects of ageing. During exercise, there is a 10-20% increase in oxygen use. This increases free radicals and so antioxidants may be needed to prevent damage to healthy cells and tissues. Two particular examples are: regular exercising, where vitamin B12 is needed in greater quantities and vitamin B3 is advised for removing LDL cholesterol; and endurance events, where it is advisable to increase vitamin C dosage and take co-enzyme 10 (found in liver, oily fish, peanuts, sesame seeds, soy, spinach or in a supplement).

During exercise, fluid losses increase and so it is essential to drink at least three pints or one and a half litres of non-dehydrating fluid a day.

It should be noted that strength, flexibility, body composition and muscle mass can be improved at any age.

## Conclusion

Prevention is always better than cure and a healthy diet is one of the ways to prevent systemic eye disease. As eating four to five portions of fruit and vegetables a day may not be realistic, a shortfall may exist. However, supplements are available to counteract this, which may also be beneficial for both forms of AMD.

Patients should always be advised to keep their eyes protected from the sun, keep hydrated and to exercise regularly. In an ideal world, we would choose four fit and healthy grandparents since no matter how well we eat or exercise, there are no guarantees against disease and, at present, there is little we can do about genetic factors.

Remember that patients should always be advised to consult their GP before changing their diet or embarking on an exercise programme.

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