Key Papers on Eye Health

Introduction

Lifestyle factors have been linked to many general health conditions and there is widespread awareness of the many benefits of a healthy diet, regular exercise, and avoiding smoking and excessive alcohol consumption. Yet until recently little attention has been paid to the influence of lifestyle on eye health.

Growing evidence is now emerging for relationships between various exposures and common eye diseases. For some potential risk factors, such as smoking, the evidence is compelling, while associations with other behaviours are less well supported in the literature or findings are contradictory.

Eye care professionals need to keep abreast of the latest thinking on lifestyle and eye health in order to provide accurate advice to patients. This literature review is intended as an introduction to this complex and fascinating subject. It describes some of the landmark studies on eye health, summarises current research findings and suggests resources for further information.

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Recommended reading for general overview

Lifestyle and eye health


- Extensive review of associations between lifestyle exposures/behaviours and eye disease
- Reviews cataract, AMD, diabetic retinopathy, open angle glaucoma, trauma, dry eye, refractive error by risk factor
- Some exposures, such as smoking, are significantly associated with risk of several different diseases
- Although data are imperfect, lifestyle alterations may reduce risk of eye disease at little or no risk to the individual


- Comprehensive review of research on the relationship between lifestyle exposures and the risk/development of age-related eye diseases
- Reviews association between UV exposure, smoking and nutrients with age-related macular degeneration (AMD) and cataracts
- Considers research findings in the context of public health advice.
- Conclusions:
  - Smoking is a major risk factor for cataract and macular degeneration
  - There is moderate evidence that high exposures to sunlight are associated with increased risk of cataract and AMD
  - High dietary intakes of antioxidants can protect against AMD and cataract. Although the evidence is inconsistent, data suggests that vitamin C and the carotenoids lutein and zeaxanthin play a critical role in eye health. Overall evidence supports general healthy eating guidelines for the consumption of fruit and vegetables and oily fish
General / Lifestyle – Resources


The Healthy Sight Institute http://www.healthysightinstitute.org/

Royal College of Ophthalmologists. Ocular public health http://www.rcophth.ac.uk/about/public/public-health


Synonyms Key

<table>
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<tr>
<td>AMD</td>
<td>Age-related Macular Degeneration</td>
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<td>ARM</td>
<td>Age-related Maculopathy</td>
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<td>AREDS</td>
<td>Age Related Eye Disease Study</td>
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<tr>
<td>ETS</td>
<td>Environmental Tobacco Smoke</td>
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<td>POAG</td>
<td>Primary Open Angle Glaucoma</td>
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<td>PSC</td>
<td>Posterior Sub Capsular</td>
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<td>DES</td>
<td>Dry Eye Syndrome</td>
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<td>FA</td>
<td>Fatty Acids</td>
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<td>EPO</td>
<td>Evening Primrose Oil</td>
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<td>NHS</td>
<td>National Health Service</td>
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<tr>
<td>UVR</td>
<td>Ultra Violet Radiation</td>
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<td>HEI</td>
<td>Healthy Eating Index</td>
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Landmark studies

**The Age-Related Eye Disease Study (AREDS)**

https://web.emmes.com/study/areds/ (dedicated website)

- Sponsored by the US National Eye Institute (http://www.nei.nih.gov/amd/)
- Investigated natural history and risk factors of age-related macular degeneration (AMD) and cataract
- Randomised, placebo-controlled, clinical trial evaluating effect of high-dose antioxidants and zinc supplementation on progression of AMD and cataract

AREDS followed 4,700 subjects in US with varying stages of AMD from January 1998. The NEI has since launched AREDS2 involving 100 clinical centres and c4,000 study participants ages 50 - 85 who have AMD. Participants will be followed for 5-6 years. http://www.areds2.org/

Key findings: High levels of antioxidants and zinc significantly reduce the risk of advanced AMD and associated vision loss but have no significant effect on the development or progression of cataract.


**Beaver Dam Eye Study**

http://www.bdeyestudy.org/node/1 (dedicated website)

- Funded by the NEI to investigate prevalence and incidence of age-related cataract, AMD and diabetic retinopathy and their causes
- Now examining relationship of long-term exposures (eg, blood pressure, lipid levels, exposure to UV-light, and medications) to these eye conditions

Began in 1989 in Beaver Dam, Wisconsin and involved c5,000 subjects aged 43-84 years at baseline, followed at 5, 10, 15 and 20 years.

Key findings: Association of cigarette smoking with cataract and AMD. Also looked at dry eye – smoking, caffeine use and multivitamins among factors investigated but with conflicting results.

**Blue Mountains Eye Study**

http://www.cvr.org.au/bmes.htm (summary of study and findings)

- First large population-based assessment of visual impairment and common eye diseases of a representative older (49-97) Australian community sample
- Assessed visual impairment, cataract, AMD, glaucoma, other vascular retinopathy, other general health measures.
- Also questioned on types of food they consumed

Key findings: Increased risk of nuclear cataract with smoking and heavy alcohol, while higher dietary intakes of protein and vitamins were protective. For cortical cataract, alcohol intake and higher dietary polyunsaturates were protective. Sunlight exposure, smoking and higher dietary salt were all associated with a higher risk of posterior subcapsular cataract. Four-fold increased risk of late-stage AMD among smokers than past or non-smokers, and 10-year earlier onset than non-smokers. Higher fish consumption protective against AMD but increased risk with higher consumption of dietary fat. Diabetes associated with higher rates of obesity.


**Among other major studies:**

**Los Angeles Latino Eye Study**


- Funded by NEI, the largest, most comprehensive epidemiological analysis of visual impairment in Latinos conducted in the US
- Assessed risk factors for eye disease and measuring health-related and vision-related quality of life
- Investigated prevalence of visual impairment, blindness, cataract, glaucoma, diabetic retinopathy, and AMD

LALES followed 6,300 Latinos, primarily Mexican-Americans, aged 40 and older from the Los Angeles area. Results first reported in 2003.

Key findings: Showed differences in eye disease prevalence between ethnic groups. Risk factors for visual impairment included low education and unemployment. Unmarried status associated with increased risk of glaucoma but no association found for smoking or alcohol use. Smoking and heavy alcohol consumption, particularly beer, associated with greater risk of advanced AMD


Smoking

Overview: Smoking is an important factor in eye health. Many studies have indicated a role for smoking in the incidence and progression of AMD. Smoking is also consistently associated with nuclear cataract but there is limited evidence of a relationship with other types of cataract. Data on smoking and glaucoma, diabetic retinopathy and dry eye are inconclusive. Contact lens wearers who smoke have an increased risk of microbial keratitis compared to non-smokers. Awareness of the link between smoking and eye disease is low and there is currently an untapped opportunity for ECPs to educate patients on this issue. In view of the known effects on general health, sensible advice is not to smoke.

Smoking and eye health - General


- Claims most chronic ocular diseases, with possible exception of diabetic retinopathy and glaucoma, appear to be associated with smoking
- Cataract and AMD, the leading causes of severe visual impairment and blindness, are directly accelerated by smoking
- Smoking is direct cause of tobacco-alcohol amblyopia
- Increased risk of blindness should be added to arguments against smoking

http://bjo.bmj.com/content/92/10/1304.abstract (abstract)

- Literature review on environmental tobacco smoke (ETS) and eye disease
- Says active smoking has been proposed to be a risk factor in AMD, Graves ophthalmology, glaucoma, uveitis, refractive errors, strabismus, tobacco-alcohol amblyopia, non-arteritic ischaemic optic neuropathy, Leber optic neuropathy and diabetic retinopathy but literature on some conditions scarce
- Data on ETS and eye disease insufficient to draw conclusions but should be addressed in future studies

Smoking and AMD

http://www.nature.com/eye/journal/v19/n9/abs/6701978a.html (abstract)

- UK-based review of epidemiological evidence associating smoking with AMD
- Of 17 studies reviewed, 13 found a statistically significant association
- 2-3X increased AMD risk in current smokers compared with never-smokers
Evidence of dose-response, temporal relationship and reversibility of effect
Cigarette smoking likely to have toxic effects on the retina
Highlights lack of awareness about the risks of developing eye disease from smoking among both healthcare professionals and the general public.


AREDS participants aged 60-80 ranging from no AMD to advanced AMD in one eye
Those with drusen, neovascular AMD or geographic atrophy were more likely to be smokers
Avoidance of smoking may reduce the risk of developing AMD
Prevention of vision impairment may be used as a motivating factor to help them modify this risk factor


http://aje.oxfordjournals.org/cgi/reprint/147/2/103 (full text)

Men who smoked more cigarettes were more likely to develop early AMD than men who had smoked less
Current smokers (men and women) had higher odds of developing large drusen after 5 years than those who had never smoked or had quit
Smoking appears to be related to the incidence of some lesions associated with early age-related maculopathy.

Smoking and cataract


http://www.jcrsjournal.org/article/S0886-3350(05)00527-4/abstract (abstract)

UK-based review of 27 epidemiological studies on smoking and cataract
Found strong association, particularly for nuclear cataract
Smoking associated with 3-fold increase on risk for incident nuclear cataract
Limited evidence of an association between smoking and posterior subcapsular cataract, and little or no association with cortical cataract


- Frequencies of more severe nuclear sclerosis increased with packyears of cigarette smoking in women and men
- Frequencies of posterior subcapsular opacities also increased in both sexes with increased packyears
- No significant effect on cortical opacities
- Smoking was associated with past cataract surgery


http://archopht.ama-assn.org/cgi/reprint/115/10/1296 (pdf)

- Investigates associations between alcohol consumption, tobacco smoking, and cataract
- Those who had ever smoked cigarettes had a higher prevalence than non-smokers of more severe nuclear and posterior subcapsular cataracts
- Association between pipe smoking and nuclear cataract was stronger than the association with cigarette smoking

Smoking and glaucoma


- Review of 11 epidemiological studies on smoking and POAG
- Found mostly poor methodology and little evidence for a causal association
- Further, high-quality studies needed
- Highlights importance of warning ophthalmic patients of the dangers of smoking and providing cessation support, because clear evidence of links between smoking and other ocular and systemic diseases

Smoking and diabetic retinopathy


http://www.ophsource.org/periodicals/ophtha/article/S0161-6420(98)96025-0/abstract (abstract)
- Examines potential risk factors for vision loss among younger onset insulin-dependent diabetics
- Loss of vision associated with more pack years smoked

**Smoking and dry eye**


- Part of Beaver Dam Eye Study
- Estimates 10-year incidence and risk factors in older population aged 43-86
- No significant association between dry eye and smoking (or caffeine use)

**Smoking and contact lens-associated microbial keratitis**


http://www.ophsource.org/periodicals/ophtha/article/S0161-6420(08)00307-2/abstract (abstract)

- Establishes risk factors for contact lens-related microbial keratitis
- Odds ratio for daily wear users was 2.96X in current smokers compared to non-smokers

**Painter J and Crossland M. Smoking, eye disease and smoking cessation strategies. Optometry in Practice 2006;7:147-154.**

http://www.college-optometrists.org/coo/download.cfm?uuid=BD03536F-6565-4EB2-97D43BE8D2F97BB5&type=oip (full text)

- Reviews smoking and AMD, cataract, glaucoma, other optic nerve disease, other eye disease
- Outlines ‘five As’ approach to smoking cessation in primary care, NHS Stop Smoking Services and nicotine replacement therapies

**Smoking cessation – attitudes of optometrists and public**


http://www3.interscience.wiley.com/journal/118520621/abstract?CRETRY=1&SRETRY=0 (abstract)
Few community optometrists routinely asked about smoking habits: only 6.2% at new patient consultations, and 2.2% at follow-up visits

Reasons given: not their role, lack of time and forgetting to ask

Overall 67.6% community optometrists wanted to improve their knowledge of smoking and visual impairment with 56.2% requesting further training

Untapped opportunities to develop brief interventions to promote smoking cessation services in community optometry settings.


http://www.nature.com/eye/journal/v19/n9/abs/6701955a.html (abstract)

Survey of adult patients attending UK district general hospital ophthalmology, general surgery, and orthopaedic clinics

Only 9.5% of patients believed smoking was definitely or probably a cause of blindness, compared with 92.2% for lung cancer, 87.6% for heart disease, and 70.6% for stroke

About one-half of smokers stated that they would definitely or probably quit smoking if they developed early signs of blindness

Link between smoking and eye disease should be publicised


http://bjo.bmj.com/cgi/content/full/91/5/605 (abstract)

Survey of teenagers attending four organised social events

Only 5% believed smoking caused blindness, whereas 15%, 27% and 81% believed that smoking caused stroke, heart disease and lung cancer

Subjects were significantly more fearful of blindness than other conditions

More teenagers said they would stop smoking on developing early signs of blindness compared with early signs of lung or heart disease.

Teenagers should be made more aware of the ocular risks of cigarette smoking as a novel public health measure
Smoking – Resources

oking.hcsp

RNIB helpline: 0845 766 9999

Quitline. Website, helpline 0800 00 22 00 and QUIT pack. http://www.quit.org.uk/

National Smoking website: http://www.givingupsmoking.co.uk
and hotline 0800 169 0169

Royal College of Ophthalmologists factsheets (with population statistics)
http://www.rcophth.ac.uk/docs/college/patientinfo/Smoking_and_Eye_Disease.pdf
http://www.rcophth.ac.uk/docs/college/patientinfo/Smoking_your_Sight_Away.pdf

NHS Choices. Smoking
http://www.nhs.uk/LiveWell/Smoking/Pages/smokingnewhome.aspx

Department of Health – advice on Tobacco
Diet

**Overview:** Eating a healthy, balanced diet will provide all of the nutrients required to keep the body healthy and may help maintain eye health.

Due to antioxidant activities in the eye, many studies on diet and eye health have focused on a potential role for the antioxidant vitamins C and E and the carotenoids (plant pigments) B-carotene, lutein and zeaxanthin, especially in AMD and cataract. Research has investigated the effect of these nutrients within the diet (ie within foods) and/or when taken as dietary supplements.

Research on this topic is derived from both from observational and intervention studies; it is important to take study design into account when interpreting research outcomes, especially when causal links cannot be established.

Overall, epidemiological data provide evidence for a protective effect of high antioxidant intakes (such as vitamins C and E) against AMD and cataract. Some observational data suggest higher dietary intakes of carotenoids, especially lutein and zeaxanthin, may protect against cataract and AMD. However, research in this area is inconsistent; the US Food and Drug Administration has concluded there is insufficient evidence to support a protective role of lutein and zeaxanthin for risk of cataract and AMD. A diet high in omega-3 fat and low in total fat may decrease the risk of developing AMD and slow its progression. Intervention studies have shown that a specific high dosage of antioxidants could help to reduce the risk of advanced AMD for people who already have moderate AMD, although high doses of supplements are contraindicated in some groups (eg smokers). Intervention studies have generally found no benefit of vitamin supplementation on cataract.

Controlled intervention trials have shown that foods high in omega-6 fatty acids may improve dry eye symptoms in women and some dietary supplements are also effective in managing dry eye.

Overall, a healthy, balanced diet can protect against age-related eye disease; evidence supports general dietary guidelines for the consumption of a diet rich in fruit and vegetables, especially fruit high in vitamin C and vegetables high in lutein and zeaxanthin. It is important that nutrients are obtained through a healthy, balanced diet; vitamin/mineral supplements are not a substitute and are of no proven benefit in the prevention of age-related disease. Those diagnosed with AMD and considering supplements are advised to consult their doctor. A healthy, balanced diet will also help to protect against other conditions associated with eye health such as obesity, diabetes and hypertension.

Note: Studies in this section are classified by experimental design to help readers exercise caution, where necessary, when interpreting research outcomes.

**The authors would like to acknowledge Kiran Rahelu, Nutrition Specialist, for her expert review and input to this section.**
**Diet and Age-Related Macular Degeneration**

**Observational studies**

**Dietary supplements and AMD**


- Investigates association of vitamin, mineral, and non-vitamin, non-mineral supplements with age-related cataract, AMD and high IOP
- Little evidence of any significant associations except for small protective effect for cortical cataracts by vitamins A and D, zinc, and multivitamins and increased odds of late AMD
- Late AMD associated with incident use of vitamins A, C, and E and zinc. This may reflect advice by family, friends, and health care providers about benefits of AREDS-like supplements

**Diet / dietary supplements and AMD**


[http://www.ophsource.org/periodicals/ophtha/article/S0161-6420(02)01263-0/abstract](http://www.ophsource.org/periodicals/ophtha/article/S0161-6420(02)01263-0/abstract) (abstract)

- Investigates associations between dietary intake, including modest supplement intake, of antioxidant vitamins and zinc at baseline and 5-year incidence of early age-related maculopathy (ARM)
- No associations found between baseline intake of alpha-carotene, beta-carotene, beta-cryptoxanthin, lutein and zeaxanthin, lycopene, retinol, vitamin A, and zinc, and 5-year incidence of early ARM
- Increasing baseline intakes of vitamin C, from diet and supplements, associated with increased risk of early ARM
- No evidence of protection associated with usual dietary antioxidant or zinc intakes (including use of supplements) on 5-year incidence of early ARM

**Diet and AMD**


[http://bjo.bmj.com/cgi/content/abstract/bjo.2008.143412v1](http://bjo.bmj.com/cgi/content/abstract/bjo.2008.143412v1) (abstract)
Part of AREDS
Progression to both dry and wet AMD was 25% less likely among those eating a diet rich in omega-3 fatty acids (DHA or EPA).
A high omega-3 diet combined with a low glycaemic index (GI) carbohydrate intake reduced the risk of progression to advanced disease even further, cutting it by 50%
Eating two to three servings of oily fish, such as salmon, tuna, mackerel and herring every week, would achieve the recommended daily intake of omega 3, cutting the risk of both early and late stage AMD

http://archopht.ama-assn.org/cgi/content/abstract/127/5/674 (abstract)

- Evaluates associations between past dietary fat intake and AMD prevalence
- Higher trans-unsaturated fat intake associated with increased prevalence of late AMD
- Higher omega-3 fatty acid intake inversely associated with early AMD
- Olive oil intake associated with decreased prevalence of late AMD
- No significant associations for intakes of fish, total fat, butter, or margarine
- Diet low in trans-unsaturated fat and rich in omega-3 fatty acids and olive oil may reduce risk of AMD

http://archopht.ama-assn.org/cgi/content/abstract/127/5/656 (abstract)

- Part of Blue Mountains Eye Study
- Assesses relationship between baseline dietary fatty acids and 10-year incident AMD
- One serving of fish per week associated with reduced risk of incident early AMD, primarily among those with less than median linoleic acid consumption
- Similar findings for intake of long-chain omega-3 polyunsaturated fatty acids
- One to two servings of nuts per week associated with reduced risk of incident early AMD
- Supports protection against early AMD from regularly eating fish, greater consumption of omega-3 polyunsaturated fatty acids, and low intakes of foods rich in linoleic acid. Regular consumption of nuts may also reduce AMD risk

http://archopht.ama-assn.org/cgi/content/abstract/119/8/1191 (abstract)
• Case-control study evaluating relationship between intake of total and specific types of fat and risk for advanced AMD

• Higher intake of specific types of fat, including vegetable, monounsaturated, and polyunsaturated fats and linoleic acid, rather than total fat intake may be associated with a greater risk for advanced AMD

• Diets high in omega-3 fatty acids and fish were inversely associated with risk for AMD when intake of linoleic acid was low


http://archopht.ama-assn.org/cgi/content/abstract/118/3/401?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=leeder+sr&searchid=1&FIRSTINDEX=0&resourcetype=HWCIT (abstract)

• Assesses whether dietary intake of fat or fish is associated with age-related maculopathy (ARM) prevalence

• Higher frequency of fish consumption was associated with decreased odds of late ARM

• Subjects with higher energy-adjusted intakes of cholesterol were significantly more likely to have late ARM, with an increased risk for late ARM for the highest compared with the lowest quintile of intake

• The amount and type of dietary fat intake may be associated with ARM


http://aje.oxfordjournals.org/cgi/content/abstract/169/7/867 (abstract)

• Higher red meat intake positively associated with early AMD

• Odds ratio for consumption of red meat > or =10 times/week versus <5 times/week was 1.47

• Similar trends seen with higher intakes of fresh and processed red meat.

• Consumption of chicken > or =3.5 times/week versus <1.5 times/week was inversely associated with late AMD

• Different meats may differently affect AMD risk and may be a target for lifestyle modification

Intervention studies

Intervention studies currently underway include AREDS 2. http://www.areds2.org/

http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=11594942 (full text plus corrections and comments)

- Investigates effects of antioxidant and zinc supplementation on progression of AMD in subjects (median age 69 years) with intermediate ARM or late AMD at baseline
- Significant odds reduction for development of advanced AMD with antioxidants plus zinc supplementation.
- Persons older than 55 years in high-risk group, and without contraindications such as smoking, should consider taking a supplement of antioxidants plus zinc such as that used in this study


http://www.nature.com/eye/journal/v22/n6/abs/eye2008100a.html (abstract)

- Examines evidence from 3 randomised, placebo-controlled trials investigating whether antioxidant vitamin or mineral supplements prevent development of AMD or slow progression
- No evidence that antioxidant (vitamin E or beta-carotene) supplementation prevented AMD
- Antioxidant (beta-carotene, vitamin C, and vitamin E) and zinc supplementation slowed progression to advanced AMD and VA loss
- People with AMD, or early signs, may experience some benefit from taking supplements as used in AREDS trial
- Potential harms of high-dose antioxidant supplementation must be considered. These may include increased risk of lung cancer in smokers (beta-carotene), heart failure in people with vascular disease or diabetes (vitamin E) and hospitalisation for genitourinary conditions (zinc)

**Diet & Cataract**

**Observational studies**

Dietary supplements and cataract (see also above)


http://www.ajo.com/article/S0002-9394(01)00922-9/abstract (abstract)

- Investigates relationships between use of vitamin supplements and three principal cataract types
Long-term use of multivitamins, B group and vitamin A supplements associated with reduced prevalence of nuclear or cortical cataract
Strong protective influence on cortical cataract from use of folate or vitamin B12 supplements

**Diet and cataract**


http://www.ajcn.org/cgi/content/full/87/6/1899 (full text)

Investigates relationship between antioxidant nutrient intakes measured at baseline and 10-year incidence of age-related cataract
Dietary antioxidants, including beta-carotene, zinc, and vitamins A, C, and E, assessed.
Higher intakes of vitamin C or combined intake of antioxidants had long-term protective associations against development of nuclear cataract in this older population.


http://www.ophsource.org/periodicals/ophtha/article/S0161-6420(99)00024-X/abstract (abstract)

Part of Blue Mountains Eye Study
To investigate relationships between a wide range of macro- and micronutrients and the three main types of cataract in older people
Higher intakes of protein, vitamin A, niacin, thiamin, and riboflavin were associated with reduced prevalence of nuclear cataract
Intake of polyunsaturated fats was associated with reduced prevalence of cortical cataract
No nutrients were associated with posterior subcapsular cataract


http://jn.nutrition.org/cgi/content/full/134/7/1812 (full text)

Part of Nurses' Health Study
Examines whether adherence to the dietary guidelines was associated with a lower prevalence of age-related nuclear lens opacities in
Diet quality defined according to 1) daily number of servings of fruits, vegetables, and whole grains; 2) Recommended Foods Score (RFS); and 3) Healthy Eating Index (HEI)
Women in the highest quartile category of HEI scores were significantly less likely to have nuclear opacities than those in the lowest category.


http://www.ajcn.org/cgi/content/full/75/3/540 (full text)

- Part of Nurses' Health Study
- Assesses relationship between usual nutrient intakes and age-related cortical and posterior subcapsular (PSC) lens opacities
- For women aged <60, vitamin C intake of 362 mg/d or more associated with a 57% lower odds ratio of developing cortical cataract than intake <140 mg/d
- Use of vitamin C supplements for 10 years or more associated with a 60% lower odds ratio than no vitamin C supplement use
- Prevalence of PSC lens opacities related to total carotenoid intake in women who never smoked


http://www.ajcn.org/cgi/content/full/70/4/517 (full text)

- Examines association between carotenoid and vitamin A intakes and cataract extraction in men
- Slightly lower risk of cataract extraction in men with higher intakes of lutein and zeaxanthin but not of other carotenoids or vitamin A
- Men in highest fifth of lutein and zeaxanthin intake had 19% lower risk of cataract relative to men in lowest fifth
- Among specific foods high in carotenoids, broccoli and spinach were most consistently associated with lower risk of cataract


http://archopht.ama-assn.org/cgi/reprint/109/2/244 (full text)

- Evaluates risk factors for age-related nuclear, cortical, posterior subcapsular, and mixed cataracts
- Dietary intake of riboflavin, vitamins C, E, and carotene was protective for cortical, nuclear, and mixed cataract
- Intake of niacin, thiamine, and iron also decreased risk
**Intervention studies**

There have been very few controlled trials specifically investigating the effects of diet and supplementation on cataracts; other trials designed to investigate non-eye diseases have generally found no benefits of vitamin supplementation on cataract.

**Diet & Diabetic retinopathy**

**Observational studies**

**Diet / dietary supplements and diabetic retinopathy**


- Examines the relationship between dietary and supplement intakes of vitamins C, E, and beta-carotene and risk of diabetic retinopathy.
- 387 participants with type 2 diabetes in San Luis Valley Diabetes Study
- No protective effect was observed with antioxidant nutrients
- Depending on insulin use, appeared to be potential for deleterious effects of nutrient antioxidants. Further research needed.

**Diet & Glaucoma**

**Observational studies**

**Diet / dietary supplements and glaucoma**


- Reviews modifiable lifestyle factors, such as exercise, diet, and smoking, that may influence intraocular pressure
- Epidemiologic studies on lifestyle factors are few, and current evidence suggests no environmental factors clearly associated with POAG
Diet & Dry Eye

Observational studies

Diet / dietary supplements and dry eye


- Review of ocular literature suggests sufficient dietary protein, vitamins A, B6 and C, potassium, and zinc may be necessary for normal tear function
- Excesses of dietary fats, salt, cholesterol, alcohol, protein, and sucrose associated with or suggested as causes of tear dysfunction
- No unequivocal link established between diet and remission of dry eye states in a well nourished population


- Investigates association between dietary intake of n-3 and n-6 fatty acids (FAs) and dry eye syndrome (DES) in women aged 45-84
- Higher ratio of n-6 to n-3 FA consumption associated with significantly increased risk of DES. Tuna consumption inversely associated with DES
- Higher intake of n-3 FAs associated with decreased DES incidence in women

Intervention studies

Kokke KH, Morris JA and Lawrenson JG. Oral omega-6 essential fatty acid treatment in contact lens associated dry eye. *Cont Lens Anterior Eye* 2008;31:3 141-6

http://www.contactlensjournal.com/article/S1367-0484(08)00003-9/abstract (abstract)

- Evaluates effects of evening primrose oil (EPO) on symptoms, signs and tear film characteristics in contact lens associated dry eye
- Treated for 6 months with either EPO or placebo (olive oil)
- EPO group showed significant improvement in symptom of 'dryness' at 3 and 6 months, and in overall lens comfort and tear meniscus height at 6 months


- Assesses whether 12-weeks of antioxidant dietary supplement (Oxybiane) improves signs and symptoms of DES
- Breakup time and Schirmer scores significantly increased on placebo, and symptoms of burning, itching, foreign body sensation and redness improved
- Oral antioxidants improve tear stability and quantity


http://www.nature.com/ejcn/journal/v55/n7/abs/1601186a.html  (abstract)

- Assesses oral antioxidant supplement (Vitabiotics) for marginal dry eye
- Tear stability and ocular surface status significantly improved at 1 month
- Increased stability correlated with change in goblet cell population density
- Tear volume not improved and dry eye symptoms subject to placebo effect
Resources on diet and eye health

NHS Choices. Eye health
http://www.nhs.uk/Livewell/Eyehealth/Pages/Lookingafteryoureyes.aspx

All About Vision website. Nutrition and vitamins for your eyes.
http://www.allaboutvision.com/nutrition/

http://www.nutrition.org.uk/home.asp?sitId=43&sectionId=299&which=1

Sources of different nutrients in the diet

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<tr>
<th>Nutrient</th>
<th>Dietary sources</th>
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<tr>
<td>Vitamin A</td>
<td>Cheese, eggs, oily fish (such as salmon, fresh tuna and mackerel), milk, margarine, yoghurt. Carrots, dark green leafy vegetables and orange-coloured fruits (eg mangoes and apricots) contain carotenoids, which are converted to vitamin A in the body</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>Found in a wide variety of fruit and vegetables. Good sources include peppers, broccoli, Brussels sprouts, sweet potatoes, oranges and kiwi fruit</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>Plant oils such as soya, corn and olive oil. Nuts and seeds, and wheatgerm (found in cereals and cereal products)</td>
</tr>
<tr>
<td>Zinc</td>
<td>Meat, shellfish, milk and dairy foods such as cheese, bread, and cereal products such as wheatgerm</td>
</tr>
<tr>
<td>Lutein, zeaxanthin</td>
<td>Spinach, kale, broccoli, red, orange and yellow peppers, mangoes, bilberries and corn</td>
</tr>
<tr>
<td>Omega-3 fats</td>
<td>Best sources are oily fish such as salmon, fresh tuna, trout and mackerel; vegetarian sources include vegetable oils, such as linseed, flaxseed, and rapeseed, and walnuts</td>
</tr>
</tbody>
</table>

Note: Patients should be advised to follow a healthy, balanced diet, in line with government recommendations (eg 5-a-day fruit and vegetable message), to obtain these nutrients; vitamin supplements are not a substitute for a healthy diet. See www.eatwell.gov.uk for a summary of government dietary advice.
**Alcohol**

**Overview:** Although some studies have found an association between alcohol intake and common eye diseases, the literature in this area is not as compelling as it is for smoking. Moderate consumption of alcohol does not appear to have a negative impact on eye health and some studies suggest possible protective effects from moderate drinking. Avoidance of heavy drinking is recommended for eye and general health reasons, especially when combined with smoking or poor diet. Excessive alcohol intake should also be avoided in pregnancy since it can lead to foetal alcohol syndrome which includes ocular anomalies.

**Alcohol and eye disease - General**


http://www.ophsource.org/periodicals/ophtha/article/S0161-6420(09)00366-2/abstract (abstract)

- Examines associations between alcohol consumption and ocular diseases in 4,141 adults in China of whom 549 were moderate beer or wine drinkers
- Alcohol consumption was not a significant risk factor for AMD, glaucoma, diabetic retinopathy, retinal vein occlusion, pterygium, trachoma, optic nerve atrophy, dry eye, cortical cataract, subcapsular posterior cataract or nuclear cataract


http://www.surveyophthalmol.com/article/S0039-6257(08)00113-6/abstract (abstract)

- Literature on association between alcohol consumption and eye disease weak
- Review shows no consistent evidence for a major role of moderate alcohol consumption in development/progression of common eye diseases.
- Effect of heavy alcohol consumption on different ocular conditions needs to be clarified


- Review of epidemiologic studies over two decades
- Chronic alcoholism associated with increased risk of cataract, keratitis, colour vision deficiencies and corneal arcus
Moderate alcohol use, however, possibly protective against AMD, cataract and diabetic retinopathy. Information on the patient's drinking history can be clinically valuable and should be collected on a routine basis.

Alcohol and AMD


http://www.ajo.com/article/S0002-9394(07)01013-6/abstract (abstract)

- Review of evidence on alcohol consumption and risk of AMD
- Of 441 studies identified, five cohort studies reviewed
- Heavy alcohol consumption (more than three standard drinks per day) associated with increased risk of early AMD.
- Association between heavy alcohol consumption and risk of late AMD inconclusive
- Although this association seems to be independent of smoking, residual confounding effects from smoking cannot be excluded completely


http://archopht.ama-assn.org/cgi/content/full/126/6/834 (full text)

- Looked at alcohol consumption among 4,229 subjects at risk of AMD
- Did not find an association between overall or specific alcohol consumption and development of early AMD or dry or wet late AMD


- Part of Beaver Dam Eye Study
- Heavy drinking (four or more drinks daily) related to 15-year cumulative incidence of pure geographic atrophy in men
- No consistent associations with amount of beer, wine, or liquor consumption and incidence or progression of AMD
- Alcohol consumption unlikely to strongly increase (or decrease) risk of AMD
Alcohol and cataract

http://archopht.ama-assn.org/cgi/reprint/115/10/1296 (pdf)

- Investigates associations between alcohol consumption, tobacco smoking, and cataract
- Only adverse effect of alcohol was among smokers: people who smoked and drank heavily had increased prevalence of nuclear cataract

http://archopht.ama-assn.org/cgi/reprint/111/1/113 (pdf)

- History of heavy drinking related to more severe nuclear sclerotic, cortical, and posterior subcapsular opacities even after adjusting for other risk factors such as smoking
- Moderate alcohol consumption associated with less severe nuclear sclerosis and participants who drank wine had less severe nuclear sclerosis and cortical opacities than those who did not
- Increased consumption of beer related to increased risk of cortical opacities

Alcohol and dry eye


- Part of Beaver Dam Eye Study
- Estimates 10-year incidence and risk factors in older population aged 43-86
- Incidence of dry eye less in subjects consuming alcohol
Government guidelines for alcohol consumption

Men should drink no more than 3-4 units a day
Women should drink no more than 2-3 units a day

- A unit is half a pint of standard strength (3 to 5% ABV) beer, lager or cider, or a pub measure of spirit. A glass of wine is about 2 units and alcopops are about 1.5 units.
- Heavy or binge drinking should be avoided; there is no strict medical definition for heavy drinking, although The Office of National Statistics defines heavy drinking as:
  - 8 or more units of alcohol per day for men
  - 6 or more units of alcohol per day for women
Recreational drugs

**Overview:** Misuse of drugs can result in a range of ocular effects. Marijuana decreases IOP but its medical value in glaucoma has not yet been investigated to the extent that it can be recommended as a therapeutic drug.

Recreational Drugs - General


[http://www.surveyophthalmol.com/article/0039-6257(86)90062-7/abstract](http://www.surveyophthalmol.com/article/0039-6257(86)90062-7/abstract) (abstract - may be worth accessing full text)

- Abuse of drugs, including some used clinically and others with no legal or clinical use, can cause ocular injury and disease
- Ocular manifestations of drug abuse may be due to the substances themselves, to invasive methods of administration, or to injury suffered during states of altered consciousness
- Grouping the drugs into five categories (opiates, marijuana, stimulants, depressants and hallucinogens), the authors describe the pharmacologic, congenital, toxic, infectious, embolic, and psychological ocular manifestations of their abuse.

Firth AY. Ocular sequelae from the illicit use of class A drugs. *Br Ir Orthopt J* 2004;1: 10-18.


- Highlights changes in visual system of the class A drug abuser
- Literature review of ocular/visual sequelae of more common class A drugs
- Include stimulants (cocaine and crack cocaine), narcotics (heroin, morphine, methadone) and hallucinogens (ecstasy, lysergic acid diethylamide, magic mushrooms, mescaline, phencyclidine)
- Ocular sequelae affecting visual acuity, the eye and adnexa, ocular posture and ocular motility can result from recreational use of these drug(s)
- Awareness of the consequences of illicit drug use should lead to more pertinent questioning during history-taking.


- Case series of patients with corneal complications with crack cocaine use
• Crack cocaine users appear to represent a unique subset of young patients predisposed to infectious keratitis and corneal epithelial defects
• Ophthalmologists and public should be aware of these associated complications

Recreational drugs and glaucoma

Ben Amar M. Cannabinoids in medicine: A review of their therapeutic potential. *J Ethnopharmacol* 2006;105(1-2) 1-25


• Meta-analysis of 72 studies of therapeutic potential of cannabinoids
• Cannabinoids (cannabis, marijuana, hashish) have therapeutic potential for range of conditions, including glaucoma

Recreational drugs – Resources

Drug misuse. NHS Choices
http://www.nhs.uk/conditions/drug-misuse/Pages/Introduction.aspx

Drug misuse. Department of Health

http://one.aao.org/CE/PracticeGuidelines/Therapy_Content.aspx?cid=9871fa42-cf40-4c1f-b05c-c816d5f93126
Exercise

Overview: The effects of physical activity and active lifestyle on eye health are not well documented although these are important modifiable behaviours in maintaining general health. What evidence there is in the literature favours regular exercise, particularly when combined with a healthy diet and avoidance of smoking. Exercise may reduce the risk of sight loss from arterio-sclerosis, hypertension and diabetes.

General


- Review of effects of acute exertion and regular physical activity on ocular physiology and disease
- Intraocular pressure transiently reduced by dynamic exercise
- For most patients exercise is beneficial to the eyes by reducing risk of central retinal vein occlusion and neovascular AMD, and by improving control of systemic hypertension and diabetes
- Ophthalmologists should be advocates of regular exercise with appropriate eye protection.

Exercise and AMD


http://bjo.bmj.com/content/90/12/1461.abstract (abstract)

- After controlling for other factors eg body mass index (BMI), people with active lifestyle (regular activity > or =3 times/week) at baseline less likely to develop exudative AMD compared with people without an active lifestyle.
- Physical activity not related to early AMD or pure geographic atrophy
- Suggests possible modifiable behaviour that might be protective against developing AMD

Exercise and diabetic retinopathy


http://pediatrics.aappublications.org/cgi/content/abstract/78/6/1027

- Association of physical activity to diabetic complications in type I diabetics
- Participation in team sports in high school or college not associated with decreased prevalence of severe retinopathy or blindness later in life
Exercise and glaucoma


(PubMed abstract only)

- As yet, little modification of lifestyle (diet, drugs, emotion, activity, or risk factors for cardiovascular disease or diabetes) can be advised to reduce risk of developing chronic open-angle glaucoma
- For patients in good general health, and motivated, an aerobic exercise program might provide small decrease in IOP
- If modifiable risk factors become known, may give patient more control over disease by altering their lifestyle.


- Small study investigating effects of walking, jogging, and running fast until exhaustion on IOP in normal and glaucomatous subjects
- With all means of exertion, IOP decreased. Glaucoma patients had greater drop and longer duration of post-exercise recovery than normal subjects
- Light exercise, such as walking, should be encouraged for glaucoma patients

Exercise - Resources

Exercise and eyesight. Royal College of Ophthalmologists
http://www.rcophth.ac.uk/docs/college/patientinfo/Exercise_and_Eyesight.pdf

Exercise. NHS Choices
http://www.nhs.uk/conditions/exercise/Pages/Introduction.aspx

British Heart Foundation
http://www.bhf.org.uk/keeping_your_heart_healthy/staying_active.aspx

**Government recommendations for physical activity**

**Aim for 30 minutes of moderate intensity exercise at least 5 days a week**

- Moderate intensity means working hard enough to be breathing more heavily than normal and becoming slightly warmer, but not so intense that you are unable to talk and exercise at the same time
- Examples of activity: brisk walking, gardening, cycling, swimming, dancing and jogging
Obesity

Overview: Obesity, defined as body mass index (BMI) of 30 or over, is increasingly discussed as a risk factor for sight loss. It has been linked to increased risk of developing common eye diseases; independent of its association with diabetes, studies have shown that body mass index or other measures of adiposity are predictive of cataract. However, not all associations between obesity and eye disease are consistent. Obesity is a significant and growing public health issue and increases the risk of many health conditions with ocular effects, such as hypertension and diabetes.

Obesity and eye health – General


- Little known about ocular manifestations of obesity but has been linked with cataract, glaucoma, AMD and diabetic retinopathy
- Studies support association between obesity and risk of age-related cataract
- Strong evidence obesity associated with elevated intraocular pressure
- No consistent association between obesity and AMD or diabetic retinopathy
- Present literature inadequate to establish any convincing associations
- Whether weight loss reduces the risk of eye diseases remains unresolved
- Because of potential public health impact of obesity, there is a greater need to understand its ocular effects.

Habot-Wilner Z and Belkin M. Obesity is a risk factor for eye disease. Harefuah 2005;144:11 805-9, 821.


- Reviews effects of obesity on the four major blinding eye diseases: AMD, diabetic retinopathy, cataract and glaucoma and shows obesity is a significant risk factor for these diseases and hence to blindness

Obesity and AMD


AREDS participants aged 60-80 ranging from no AMD to advanced AMD in one eye
Only those with neovascular AMD were more likely to have increased BMI

Obesity and cataract


http://aje.oxfordjournals.org/cgi/content/abstract/169/10/1267?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&fulltext=chong+ew&searchid=1&FIRSTINDEX=0&resourcetype=HWCIT

- Population-based study among Singaporean Malay adults
- Obesity significantly associated with cortical cataracts but not nuclear cataract
- Results did not support causal association between obesity and cortical or posterior subcapsular cataract
- Fat mass- and obesity-associated gene may be involved in the pathogenesis of nuclear cataract

Obesity – Resources


Department of Health website, Obesity http://www.dh.gov.uk/en/Publichealth/Healthimprovement/Obesity/DH_6585

National Obesity Forum http://www.nationalobesityforum.org.uk/

**Government information on obesity**

Body mass index (BMI) is calculated by dividing a person’s weight measurement (kg) by the square of their height (m). In adults, a BMI of 25 to 29.9 means that person is considered to be overweight, and a BMI of 30 or above means that person is considered to be obese. The BMI score for children and adolescents is related to the UK 1990 BMI growth reference charts in order to determine a child’s weight status. Certain factors such as fitness, ethnic origin and puberty can sometimes alter the relation between BMI and body fatness. In these cases other measurements such as waist circumference and skin fold thickness can also be collected to confirm a person’s weight status.
Light exposure

Overview: UV light has been shown to be a contributory factor in various ocular conditions and the benefits of UV protection are well recognised. UV exposure may cause damage to the retinal pigment epithelium but an association with AMD has not been found. Light exposure is a risk factor in cataract and seems to be a greater risk in men. Appropriate advice on UV protection is needed to help promote long-term ocular health.

Light exposure and eye health – General


http://journals.lww.com/claojournal/Abstract/1997/07000/Ultraviolet_Radiation_Revised.10.aspx (abstract)

- Significant evidence suggests a correlation between ultraviolet radiation (UVR) exposure and conjunctival pterygium, photokeratitis, climatic droplet keratopathy and cataracts
- There are compelling reasons to counsel our patients on the adverse effects of UVR and to offer them the various options available for UV protection

Light exposure and AMD


http://archopht.ama-assn.org/cgi/content/abstract/122/5/750

- Examines association of sunlight exposure and indicators of sun sensitivity with the 10-year incidence of age-related maculopathy (ARM)
- Those exposed to the summer sun more than 5 hours a day in teens, in 30s, and at baseline at a higher risk of increased retinal pigment and early ARM than those exposed less than 2 hours per day
- More than 10 severe sunburns during youth more likely than those who experienced 1 or no burn to develop drusen
- Use of hats and sunglasses at least half the time associated with decreased risk of soft indistinct drusen and retinal pigment epithelial depigmentation

Light exposure and cataract

Reviews epidemiologic evidence linking UV radiation and cataract
Majority of 22 studies reviewed support association between UV-B and the development of cortical cataract and perhaps posterior subcapsular cataract.
Data justify implementation of public health campaigns to raise public awareness of risk of cortical cataract due to ocular UV-B exposure


Investigates possible risk factors for age-related nuclear and cortical cataracts in AREDS participants aged 60-80 years
Moderate cortical opacities were associated, at a borderline level of significance, with higher levels of sunlight exposure
Consistent findings now been reported across many studies for sunlight exposure


Examines exposure to sunlight and UVB and prevalence of lens opacities
Men with higher levels of average annual ambient UVB 1.36X more likely to have more severe cortical opacities than men with lower levels
UVB not associated with nuclear sclerosis or posterior subcapsular opacities in men
No associations with UVB exposure found for women

http://aje.oxfordjournals.org/cgi/content/full/162/11/1080 (full text)

Model of possible consequences for US cataract incidence of increases in UVB radiation due to ozone depletion
By 2050, prevalence of cortical cataract will increase above expected levels by 1.3-6.9%
With 5-20% ozone depletion, there will be 167,000-830,000 additional cases of cortical cataract by 2050
Light exposure – Resources

Ultraviolet (UV) radiation and your eyes, All About Vision website.  
http://www.allaboutvision.com/sunglasses/spf.htm

UV and the eye. College of Optometrists.  

The Healthy Sight Institute  
http://www.healthysightinstitute.org/

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**RNIB recommendations for eye protection against UV damage**

**UV filters**  
Use a UV filter that stops most of the harmful rays of the sun entering the eyes. Most prescription glasses and some contact lenses now have a built-in UV filter.

**Sunglasses**  
Sunglasses with a CE mark show that they are made to an agreed European standard. There is also a British standard for sunglasses which should be looked for when buying them: BSEN 1836:1997.

**Going outside**  
In the UK, on a day to day basis, UV exposure is very small. However people who spend lots of time outdoors may need protection. Those living in countries with more sun may also need to take more care. UV exposure is also much higher where there are more reflective surfaces, for example near water, so protect the eyes while at the beach, fishing, boating or on holiday. Snow also intensifies the amount of reflected UV light, so good protection is needed in these circumstances. Skiers and snowboarders should take particular care.

Note: Government advice on sun protection for eyes and skin also includes wearing a wide-brimmed hat and wraparound sunglasses, spending time in the shade between 11am and 3pm, and taking extra care with children.

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Literature review compiled by Alison Ewbank and Jane Veys, January 2010