encyclopedia

MDPI

Entry

The Influence of Diet, Exercise and Lifestyle Factors on Ocular Health

Sandeep Kaur Dhallu

Department of Clinical, Pharmaceutical and Biological Sciences, University of Hertfordshire, Hatfield AL10 9AB, UK; s.dhallu@herts.ac.uk

Definition

The human eye is a complex organ that is prone to visual impairment from both modifiable and non-modifiable risk factors. While some lifestyle choices, such as smoking, can negatively influence the eye's visual system, others can have a positive impact. For instance, a healthy diet that includes nutrients such as lutein, zeaxanthin and meso-zeaxanthin can have a beneficial effect on macular health. Similarly, exercise can have a beneficial effect not only on general health and wellbeing but also on ocular health. This article will provide an overview of the link between modifiable risk factors such as diet, exercise, psychological stress and others on ocular diseases including dry eye disease, age-related macular degeneration, myopia, glaucoma and diabetic retinopathy. It will also evaluate whether there is a need to raise awareness amongst the general population on how simple lifestyle changes can improve ocular health.

Keywords: diet; exercise; ocular nutrition; ocular health; modifiable lifestyle factors; mental health

Academic Editors: Sansar Sharma and Raffaele Barretta

Received: 21 July 2025
Revised: 17 September 2025
Accepted: 28 September 2025
Published: 5 October 2025

Citation: Dhallu, S.K. The Influence of Diet, Exercise and Lifestyle Factors on Ocular Health. *Encyclopedia* **2025**, *5*, 159. https://doi.org/10.3390/encyclopedia5040159

1. Introduction

Globally, cataracts, glaucoma and age-related macular degeneration (AMD) are leading causes of visual impairment [1,2]. The development and progression of these conditions is influenced by different external factors, including those which can be modified by the patient themselves such as by improving their diet, leading a less sedentary lifestyle, decreasing exposure to poor air quality environments and so on. These are relatively simple and low-cost changes that a patient can make in order to improve their general as well as ocular wellbeing and could help to reduce the global economic burden of these progressive diseases.

While the general public may have an awareness of the link between these modifiable lifestyle factors and their general health, they may be less aware of the effect on their eye health. This article will explore the influence of nutrition, exercise, smoking, air pollution and psychological stress on ocular health (Figure 1).

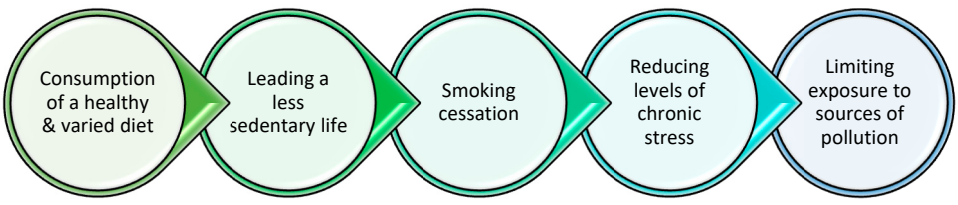

Figure 1. Five key modifiable lifestyle changes that may influence ocular health.

2. Diet

Food contains the nutrients needed by the human body to sustain life. They can be classified as macronutrients (carbohydrates, proteins and lipids) micronutrients (vitamins and minerals) and water. Carbohydrates are an important source of energy and fuel processes in the body. Proteins are important for repair and growth and are also a good source of vitamins and minerals such as iron, zinc and B vitamins. Fats and sugar are sources of energy but must be consumed in moderation. Food also contains essential micronutrients such as vitamins and minerals, which generally cannot be synthesised in the body and so need to be obtained from the diet. Micronutrients are vital to health and disease prevention and, if not consumed in adequate amounts, can lead to deficiencies which may have adverse consequences on health. Nutrition is impacted by factors such as aging, gender, ethnicity and socioeconomic factors [3].

Age-related macular degeneration (AMD) is a progressive eye disease which affects the macula, the central part of the retina, causing a loss in the sight that we use for detailed tasks. The antioxidant vitamins A, C, E, the trace element zinc and the micronutrients lutein and zeaxanthin are thought to be helpful in AMD because of the "free radical" theory of cell damage [4]. Free radicals are highly reactive substances that are created during normal bodily processes and also occur as a result of other factors like air pollution and smoking tobacco. They can damage the cells in the body, and antioxidants are thought to counteract these free radicals, hence delaying or preventing them from damaging the body's cells. Two studies (AREDS and AREDS2) investigated the role of these antioxidants on AMD progression and found that, for some people with AMD, taking an antioxidant formula slowed down disease progression [4,5]. There is believed to be a link between the gut microbiome and AMD, as well as other retinal diseases [6,7]. Diet can alter the gut microbiome and a Mediterranean diet that is rich in green vegetables, fresh produce, legumes, fruit and fish may play a role in shifting gut microbial composition more favorably and reducing AMD risk [8–10]. However more longitudinal studies are needed to explore this link further.

Cataracts occur over time as the crystalline lens ages and becomes progressively less transparent, with an accompanying loss in vision. Some research trials have found a positive link between vitamins C and E, beta-carotenoids and multivitamin supplements and either slowing down cataract formation or reducing the need for cataract surgery. However, others have found no association and so overall the evidence is inconsistent [11,12]. More high-quality research is therefore needed in order to explore any potential link further and determine whether a particular combination of vitamins and nutrients is needed or if supplements need to be taken over a longer term in order to produce a more defined effect. The AREDS study found that the use of multivitamin supplements was associated with a lower risk of developing nuclear cataracts over a follow-up period of ten years [13] and so there may be some benefit to long-term multivitamin supplementation. However, further longitudinal studies are needed.

Dry eye disease (DED) is a multifactorial disease of the ocular surface system and may be characterised by tear film instability, inflammation, tear hyperosmolarity and epithelial damage. Recently, new therapies that target inflammation and oxidative stress have been developed. There is a growing body of evidence that supports the possible role of different micronutrients for the treatment of ocular surface disease [4]. There is some evidence that long-chain omega-3 may have a positive effect on some dry eye symptoms when taken in particular quantities, however, more evidence is needed to investigate the effect on other clinical measures as well as side effects [14]. Omega-3 fatty acid is believed to play a role in the maintenance of tear stability, but not in tear production, by altering the meibomian gland secretions and meibum quality in patients suffering from meibomian gland disease

and chronic blepharitis, leading to a more stable tear film and thereby decreasing the signs and symptoms of dry eye. It has also been suggested that preformed GLA, which is found in green leafy vegetables, nuts and vegetable oils, can help to prevent dry eye symptoms [5]. An investigation into supplementation with a novel blend of omega-3 and omega-6 fatty acids in those with highly symptomatic DED (OSDI $\geq$ 52) found a clinically significant improvement in dry eye symptoms [15].

Glaucoma is recognised as a group of complex conditions that lead to optic nerve damage. As with other conditions, oxidative stress is believed to play an important role in the pathogenesis of primary open-angle glaucoma (POAG) [16] and evidence has shown that patients with POAG have an increased oxidative status [17]. Antioxidants are believed to play an important role in reducing the effects of oxidative damage, thus the possibility that nutritional supplements with antioxidative properties could be beneficial is something to be explored. It may be pertinent to consider the use of nutritional supplements alongside conventional treatment as a potential alternative therapy to slow the progression or help reduce the risk of the glaucoma. One such example is the naturally occurring compound known as coenzyme Q (CoQ), which is thought to act as a neuroprotectant in glaucoma patients. It has been suggested that DNA damage and lipid peroxidation as a result of oxidative stress can be prevented by ubiquinone, otherwise known as coenzyme Q10 [18]. Omega-3 fatty acids such as polyunsaturated fatty acid (PUFA) and DHA are thought to have antioxidative properties. Although there has been very little research carried out relating to the use of omega-3 fatty acids in glaucoma treatment specifically, it is known that these fatty acids have the ability to lower free radical levels and so may have some benefit. Ginkgo biloba extract (GBE) from the Ginkgo tree is commonly used in China and contains over 60 known bioactive compounds including flavonoids and antioxidants. The effect of GBE on ocular blood flow velocity was investigated and found to have no effect on IOP but increased ocular blood flow [19]. This holds promise as a therapeutic supplement, since reduced ocular blood flow is a factor linked with glaucomatous progression.

As well as food, drinks may also have an impact on ocular disease. Studies looking at the association of commonly consumed beverages with glaucoma have reported equivocal effects, and it has been suggested that the effects could be different among different ethnicities. A study by a group of Korean researchers investigating the link between alcohol consumption and IOP found that alcohol consumption more than twice a week was associated with increased IOP in men without POAG. They also found a link in women with POAG who drank alcohol more than 4 times a week [20]. Similarly, the effect of caffeine on the ocular surface has been investigated in numerous studies. For example, one study which investigated the link between consumption of coffee, tea or soft drinks and the risk of open-angle glaucoma in a Korean population found an association between consumption of coffee and OAG, particularly in men, but no such association was found with tea or soft drinks [21]. This was in keeping with the findings of a study from a UK biobank which found that, in those with the strongest genetic predisposition to elevated IOP, greater coffee consumption was associated with higher IOP and a higher prevalence of glaucoma [22]. Therefore, it may be appropriate for patients who need to control their IOP to consider their alcohol and coffee consumption.

There may also be a link between consumption of caffeine and alcohol and the ocular surface. Regular caffeine consumption has been found to be associated with decreased odds of DED as measured from self-reported history, symptoms and/or signs although others have shown non-significant trends [23–25]. This could be due to differences in methodology and also because they were dependent upon patients self-reporting their consumption, which could have introduced recall bias. Other studies have shown an increase in tear meniscus height and Schirmer test values in the first 2 h following a single

dose of caffeine [26]. Therefore, on balance, the evidence suggests there is a protective effect of caffeine on the ocular surface, although larger-scale studies are needed to investigate this further. Increased alcohol intake has also been reported to contribute to DED and a deterioration of the tear film [27] although this may be influenced by confounding factors and differences have been reported between genders. Long-term consumption of alcohol has also been linked with a deficiency in vitamin A, which may lead to corneal and conjunctival epithelial keratinization [28]. A deficiency in vitamin D may also play a role in DED symptoms as a result of altered corneal nerve morphology [29].

Although there are a range of different recommendations on the amounts and types of food a person should consume, nutritional requirements can vary between individuals. Eating too much or too little can both have negative effects on health. Obesity has been reported to be linked to DED [30] as well as changes in meibomian gland architecture [31]. The nutrients that can be obtained from a food source are determined by both its bioavailability and absorption [32]. For example, the availability of some nutrients can be increased by cooking, whereas other nutrients are more readily available when in their raw form. An individual's ability to absorb vitamins and minerals from food may be influenced by factors such as age, nutritional status, as well as the presence of systemic diseases like cystic fibrosis or ulcerative colitis [33] which can cause malabsorption. And so different people will have different needs and requirements from their diet. Nutritional supplements or food supplements are concentrated sources of vitamins, minerals or other substances which certain groups of people may need to use, such as young children, individuals with deficiencies, women during pregnancy and older populations. In general, it is recommended that supplements are used in addition to, and not as a substitute for, a healthy and balanced diet.

While many people are aware of the link between a poor diet and health conditions like obesity, heart disease and type 2 diabetes, there is generally less awareness of the role that nutrition can play in supporting eye health. Generally, if GPs think a patient may benefit from specialist dietary advice they can refer them to a dietitian who is trained to advise on diet and nutrition. However, there are also a number of other health care professionals, such as optometrists, who would be well placed to provide nutritional advice to the general public.

3. Exercise

Leading a more active lifestyle has many benefits on our general health and wellbeing, and the same applies to ocular health for many different ocular conditions. A study investigating the impact of aerobic exercise alone or combined with a Mediterranean diet on DED found significant improvements on dry eye parameters such as tear break up time and OSDI questionnaire scores in those who undertook the combined approach versus exercise alone [34]. AMD is a leading cause of blindness in the UK [35] and while the pathogenesis of AMD is not fully known, a lack of physical activity has been linked to the development of early precursors for AMD in the form of macular drusen [36]. Studies have indicated that there may be a neuroprotective effect associated with physical activity [37] and that physical activity may inhibit the inflammatory response by promoting the release of anti-inflammatory agents [38,39].

While exercise can cause a short-duration rise in IOP, studies have also shown a reduction in IOP soon after exercise, as well as a lower baseline IOP in glaucoma patients, suggesting that overall exercise may have a beneficial effect on IOP [40]. Most studies have investigated the impact of intense physical activity on IOP, however, emerging evidence indicates that even light activity, which reduces sedentary time, can have a positive impact [41].

Increasing physical activity has been shown to reduce the risk of developing diabetic retinopathy (DR) [42,43], and exercising for at least 30 min five times a week has been shown to reduce the risk of DR progression by 40% [44]. This is thought to occur as a result of improved regulation of blood glucose via increased insulin sensitivity, better mitochondrial function and lower blood pressure and blood lipid levels [45]. However, patients with proliferative diabetic retinopathy should avoid high-intensity aerobic and resistance exercise in order to reduce their risk of vitreous haemorrhage or retinal detachment [46]. Resistance training is a good alternative to aerobic exercise. This type of training has not been found to cause a greater number of undesirable events as compared to other types of exercise [47]. One study found that there were more complications during jogging and walking than with strength training in the elderly [48].

Interestingly, a link has also been found between physical activity and DED, with studies suggesting that exercise may help to delay the onset and/or progression of the disease by causing a temporary increase in tear volume and reduction in inflammatory biomarkers in the tears [49].

4. Air Pollution

Air pollution is recognised as a leading cause of disease [50] and estimated to have caused 4.2 million premature deaths worldwide in 2019 [51]. In recent years there has been a considerable rise in atmospheric pollution in many cities around the globe and this has led to an increased concern regarding the adverse effect of this on human health. Common pollutants include particulate matter (PM), carbon monoxide (CO), ozone (O_3), nitrogen diozide (NO_2) and sulphur dioxide (SO_2). The World Health Organization estimates that, in 2019, 99% of the world's population was living in areas above WHO air quality guideline levels [51].

As well as outdoor air pollution, indoor pollution can be problematic. Sources of indoor air pollution include tobacco smoking, cooking with oil and high heat, use of pesticides and so on [52].

The eye is directly exposed to the external environment and pollutants in the air, and so individuals that live in areas with higher concentrations of pollutants such as $PM_{2.5}$, PM_{10}, SO_2 and NO_2 may be more likely to experience eye problems related to this, including chronic eye diseases like glaucoma, age-related macular degeneration and cataracts [53,54].

Glaucoma has been found to be associated with levels of $PM_{2.5}$, NO_2 and NO_X [55–57], as well as PM_{10} [58], although the effect estimates were relatively small. Other studies have indicated a link between retinal damage and air pollution, in particular with myopic macular degeneration, AMD and diabetic retinopathy [59,60]. A large UK study found higher baseline ambient $PM_{2.5}$, NO_2 and NO_X levels to be associated with a greater risk of undergoing cataract surgery, with the highest risk relating to levels of $PM_{2.5}$ [61], however, only outdoor air pollution was assessed, with no assessment of indoor air quality levels. It has been postulated that the rich vascular supply that the retina receives allows more blood-borne pollutants to reach it in higher concentrations and as a result makes it more susceptible to adverse effects compared with other structures such as the crystalline lens [61].

Overall, current evidence suggests there is a link between air pollution and the development of certain chronic ocular diseases, however, there is some inconsistency in findings. For instance, there is inconclusive evidence in relation to the association between specific pollutants, with studies finding opposing results [13,62,63]. Therefore, further studies are needed in order to investigate this more conclusively.

5. Smoking/Vaping

Smoking can affect the ocular surface, leading to symptoms such as ocular redness, itchiness and irritation. Current and past smokers have been found to have higher IOP than those that have never smoked [64–67]. Cataracts have also been linked to smoking [68,69] as has AMD [70] and uveitis [71,72].

Smoking has also been found to impact the tear film, epithelial cells and DED, however, the evidence is somewhat inconsistent with some studies finding positive associations and others finding no association at all [73–77]. Smoking has also been associated with chalazion, although further examination of why this is the case is needed [78].

Use of electronic cigarettes, or vaping, was initially introduced as a step towards smoking cessation but they have been found to contain carcinogenic chemicals, air pollutants and heavy metals. There is limited research at the moment on the short- and long-term effects of vaping, however, adverse effects have been reported on the anterior eye and ocular surface [79].

Smoking is a modifiable factor, which has been shown to have an impact on ocular health and therefore it is important for clinicians to discuss smoking cessation in order to help improve health outcomes.

6. Mental Health and Chronic Stress

The modern lifestyle may have given rise to an increase in the frequency as well as severity of ocular surface diseases such as dry eye [28]. It is thought that mental health factors may be associated with ocular surface diseases. Depression, which is a chronic mood disorder, is a common finding in those with eye diseases, with one study finding the highest prevalence of depression in those with DED, followed by glaucoma, age-related macular degeneration and cataracts [80]. Other studies have corroborated this finding of higher rates of depression in patients with DED [81–83]. Whether there is any link with antidepressant medication use is as yet unclear [84]. One study found higher rates of DED in those who were not taking antidepressants, suggesting its association could be independent of medication use [85], however, another found a significant association between DED and longer duration of antianxiety or antidepressant medication use [86]. It is thought that increased inflammation may be a linking factor between depression and DED [87]. Correlations have also been found between DED, depression and sleep disorders with poorer sleep quality being more prevalent amongst those with DED [88]. However, it has been proposed that a two-way relationship exists between the two, and a disruption in circadian rhythm could occur as a result of DED and so further research is needed to understand this link.

Anxiety has also been linked with DED frequency and severity [89]. Several studies are in agreement that a higher number of individuals with DED suffer with anxiety disorders such as post-traumatic stress disorder, self-reported agoraphobia, self-reported panic disorder and generalized anxiety disorder [85]. Additionally, more severe DED symptoms were associated with more severe anxiety [28]. Psychological stress, as measured with self-reported questionnaires, has also been reported to have a positive association with DED [38,90].

As well as ocular surface disease, a higher rate of depression has also been found in patients with other eye diseases such as glaucoma and AMD, with a poor self-perception of health, being less able to do activities for daily living and poor visual function being risk factors for depression [39]. In general, this is a relatively under-researched area and while the existence of a potential retina–brain axis has been suggested, more research is needed in this area. It is important to consider the effect of ocular health and visual function on a

person's mental health and to consider ways of addressing sources of psychological stress in order to help alleviate the stress burden.

7. Conclusions

Vision loss is a global problem and can be caused by several eye conditions such as cataracts, AMD, glaucoma and diabetic retinopathy. Furthermore, conditions such as DED are becoming increasingly prevalent, even amongst children, and can affect quality of life as well as lead to visual disturbances especially in severe cases. Oxidative stress is thought to be a causative factor in the development of these diseases, with the eye being particularly susceptible to oxidative stress.

Lifestyle changes such as a healthy diet, leading a less sedentary lifestyle, smoking cessation and participating in more exercise as well as limiting exposure to sources of both indoor and outdoor air pollution may be important influencing factors to consider as they are relatively simple and cost-effective strategies which may yield better health outcomes for the patient in the long run. The general public may be less aware of the connection between these factors and eye health. Health care professionals such as optometrists would be well placed to provide nutritional and lifestyle advice to the general public, with a view to this being undertaken in conjunction with other treatments and/or therapies.

Many gaps still exist in our knowledge and understanding of how certain lifestyle factors affect eye health, particularly in relation to the mechanisms behind some of the reported changes. Therefore, more research is needed in order to further our understanding, so that we can address these aspects. In this way we can help to improve ocular health outcomes for patients and reduce the impact as well as burden of ocular disease.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created or analyzed in this study. Data sharing is not applicable to this article.

Conflicts of Interest: The author declares no conflicts of interest.

References

1. Flaxman, S.R.; Bourne, R.R.; Resnikoff, S.; Ackland, P.; Braithwaite, T.; Cicinelli, M.V.; Das, A.; Jonas, J.B.; Keeffe, J.; Kempen, J.H.; et al. Global causes of blindness and distance vision impairment 1990–2020: A systematic review and meta-analysis. *Lancet Glob. Health* **2017**, *5*, e1221–e1234. [CrossRef]
2. Steinmetz, J.D.; Bourne, R.R.; Briant, P.S.; Flaxman, S.R.; Taylor, H.R.; Jonas, J.B.; Abdoli, A.A.; Abrha, W.A.; Abualhasan, A.; Abu-Gharbieh, E.G.; et al. Causes of blindness and vision impairment in 2020 and trends over 30 years, and prevalence of avoidable blindness in relation to VISION 2020: The Right to Sight: An analysis for the Global Burden of Disease Study. *Lancet Glob. Health* **2021**, *9*, e144–e160. [CrossRef] [PubMed]
3. Markoulli, M.; Ahmad, S.; Arcot, J.; Arita, R.; Benitez-del-Castillo, J.; Caffery, B.; Downie, L.E.; Edwards, K.; Flanagan, J.; Labetoulle, M.; et al. TFOS Lifestyle: Impact of nutrition on the ocular surface. *Ocul. Surf.* **2023**, *29*, 226–271. [CrossRef] [PubMed]
4. Pellegrini, M.; Senni, C.; Bernabei, F.; Cicero, A.F.G.; Vagge, A.; Maestri, A.; Scorcia, V.; Giannaccare, G. The Role of Nutrition and Nutritional Supplements in Ocular Surface Diseases. *Nutrients* **2020**, *12*, 952. [CrossRef]
5. Arivuchudar, R.; Tamilchudar, R. An Overview on the Sway of Nutritional Supplements on Dry Eye Disease. *Res. J. Pharm. Technol.* **2020**, *13*, 5004–5008. [CrossRef]
6. Napolitano, P.; Filippelli, M.; Davinelli, S.; Bartollino, S.; dell'Omo, R.; Costagliola, C. Influence of gut microbiota on eye diseases: An overview. *Ann. Med.* **2021**, *53*, 750–761. [CrossRef] [PubMed]
7. Bu, Y.; Chan, Y.K.; Wong, H.L.; Poon, S.H.L.; Lo, A.C.Y.; Shih, K.C.; Tong, L. A review of the impact of alterations in gut microbiome on the immunopathogenesis of ocular diseases. *J. Clin. Med.* **2021**, *10*, 4694. [CrossRef]
8. Chapman, N.A.; Jacobs, R.J.; Braakhuis, A.J. Role of diet and food intake in age-related macular degeneration: A systematic review. *Clin. Exp. Ophthalmol.* **2019**, *47*, 106–127. [CrossRef]

9. Grant, M.B.; Bernstein, P.S.; Boesze-Battaglia, K.; Chew, E.; Curcio, C.A.; Kenney, M.C.; Klaver, C.; Philp, N.J.; Rowan, S.; Sparrow, J.; et al. Inside out: Relations between the microbiome, nutrition, and eye health. *Exp. Eye Res.* **2022**, *224*, 109216. [CrossRef]
10. Wu, Y.; Xie, Y.; Yuan, Y.; Xiong, R.; Hu, Y.; Ning, K.; Ha, J.; Wang, W.; Han, X.; He, M. The Mediterranean diet and age-related eye diseases: A systematic review. *Nutrients* **2023**, *15*, 2043. [CrossRef]
11. Weikel, K.A.; Garber, C.; Baburins, A.; Taylor, A. Nutritional modulation of cataract. *Nutr. Rev.* **2014**, *72*, 30–47. [CrossRef]
12. Mathew, M.C.; Ervin, A.M.; Tao, J.; Davis, R.M. Antioxidant vitamin supplementation for preventing and slowing the progression of age-related cataract. *Cochrane Database Syst. Rev.* **2012**, *6*, CD004567. [CrossRef]
13. Chang, K.H.; Hsu, P.Y.; Lin, C.J.; Lin, C.L.; Juo, S.H.H.; Liang, C.L. Traffic-related air pollutants increase the risk for age-related macular degeneration. *J. Investig. Med.* **2019**, *67*, 1076–1081. [CrossRef]
14. Downie, L.E.; Ng, S.M.; Lindsley, K.B.; Akpek, E.K. Omega-3 and omega-6 polyunsaturated fatty acids for dry eye disease. *Cochrane Database Syst. Rev.* **2019**, *12*, CD011016. [CrossRef]
15. Ng, A.; Woods, J.; Jahn, T.; Jones, L.W.; Ritter, J.S. Effect of a novel omega-3 and omega-6 fatty acid supplement on dry eye disease: A 3-month randomized controlled trial. *Optom. Vis. Sci.* **2022**, *99*, 67–75. [CrossRef]
16. Saccà, S.C.; Izzotti, A.; Rossi, P.; Traverso, C. Glaucomatous outflow pathway and oxidative stress. *Exp. Eye Res.* **2007**, *84*, 389–399. [CrossRef]
17. Zanon-Moreno, V.; Marco-Ventura, P.; Lleo-Perez, A.; Pons-Vazquez, S.; Garcia-Medina, J.J.; Vinuesa-Silva, I.; Moreno-Nadal, M.A.; Pinazo-Duran, M.D. Oxidative stress in primary open-angle glaucoma. *J. Glaucoma* **2008**, *17*, 263–268. [CrossRef] [PubMed]
18. Martucci, A.; Nucci, C. Evidence on neuroprotective properties of coenzyme Q10 in the treatment of glaucoma. *Neural Regen. Res.* **2019**, *14*, 197–200. [CrossRef] [PubMed]
19. Chung, H.S.; Harris, A.; Kristinsson, J.K.; Ciulla, T.A.; Kagemann, C.; Ritch, R. Ginkgo biloba extract increases ocular blood flow velocity. *J. Ocul. Pharmacol. Ther.* **1999**, *15*, 233–240. [CrossRef] [PubMed]
20. Song, J.E.; Kim, J.M.; Lee, M.Y.; Jang, H.J.; Park, K.H. Effects of consumption of alcohol on intraocular pressure: Korea National Health and Nutrition Examination Survey 2010 to 2011. *Nutrients* **2020**, *12*, 2420. [CrossRef]
21. Bae, J.H.; Kim, J.M.; Lee, J.M.; Song, J.E.; Lee, M.Y.; Chung, P.W.; Park, K.H. Effects of consumption of coffee, tea, or soft drinks on open-angle glaucoma: Korea National Health and Nutrition Examination Survey 2010 to 2011. *PLoS ONE* **2020**, *15*, e0236152. [CrossRef]
22. Kim, J.; Aschard, H.; Kang, J.H.; Lentjes, M.A.; Do, R.; Wiggs, J.L.; Khawaja, A.P.; Pasquale, L.R.; Modifiable Risk Factors for Glaucoma Collaboration. Intraocular pressure, glaucoma, and dietary caffeine consumption: A gene–diet interaction study from the UK Biobank. *Ophthalmology* **2021**, *128*, 866–876. [CrossRef]
23. Jeong, K.J.; Choi, J.G.; Park, E.J.; Kim, H.E.; Yoo, S.M.; Park, S.G. Relationship between dry eye syndrome and frequency of coffee consumption in Korean adults: Korea National Health and Nutrition Examination Survey V, 2010–2012. *Korean J. Fam. Med.* **2018**, *39*, 290. [CrossRef]
24. García-Marqués, J.V.; Talens-Estarelles, C.; García-Lázaro, S.; Wolffsohn, J.S.; Cervino, A. Systemic, environmental and lifestyle risk factors for dry eye disease in a mediterranean caucasian population. *Contact Lens Anterior Eye* **2022**, *45*, 101539. [CrossRef]
25. Magno, M.S.; Utheim, T.P.; Morthen, M.K.; Snieder, H.; Jansonius, N.M.; Hammond, C.J.; Vehof, J. The relationship between caffeine intake and dry eye disease. *Cornea* **2023**, *42*, 186–193. [CrossRef]
26. Osei, K.A.; Ovenseri-Ogbomo, G.; Kyei, S.; Ntodie, M. The effect of caffeine on tear secretion. *Optom. Vis. Sci.* **2014**, *91*, 171–177. [CrossRef]
27. Kim, J.H.; Kim, J.H.; Nam, W.H.; Yi, K.; Choi, D.G.; Hyon, J.Y.; Wee, W.R.; Shin, Y.J. Oral alcohol administration disturbs tear film and ocular surface. *Ophthalmology* **2012**, *119*, 965–971. [CrossRef] [PubMed]
28. Galor, A.; Britten-Jones, A.C.; Feng, Y.; Ferrari, G.; Goldblum, D.; Gupta, P.K.; Merayo-Lloves, J.; Na, K.S.; Naroo, S.A.; Nichols, K.K.; et al. TFOS Lifestyle: Impact of lifestyle challenges on the ocular surface. *Ocul. Surf.* **2023**, *28*, 262–303. [CrossRef] [PubMed]
29. Shetty, R.; Deshpande, K.; Deshmukh, R.; Jayadev, C.; Shroff, R. Bowman break and subbasal nerve plexus changes in a patient with dry eye presenting with chronic ocular pain and vitamin D deficiency. *Cornea* **2016**, *35*, 688–691. [CrossRef] [PubMed]
30. Acar, M.; Firat, H.; Acar, U.; Ardic, S. Ocular surface assessment in patients with obstructive sleep apnea–hypopnea syndrome. *Sleep Breath.* **2013**, *17*, 583–588. [CrossRef]
31. Gupta, P.K.; Venkateswaran, N.; Heinke, J.; Stinnett, S.S. Association of meibomian gland architecture and body mass index in a pediatric population. *Ocul. Surf.* **2020**, *18*, 657–662. [CrossRef]
32. Di Vincenzo, R.; Kierzkowska, E.; Osiecki, H. Bioavailability. *J. Complement. Med. CM* **2004**, *3*, 62–71.
33. Burke, A.; Lichtenstein, G.R.; Rombeau, J.L. Nutrition and ulcerative colitis. *Baillière's Clin. Gastroenterol.* **1997**, *11*, 153–174. [CrossRef]
34. Ismail, A.M.A.; El-Azeim, A.S.A.; Saif, H.F.A.E.A. Effect of aerobic exercise alone or combined with Mediterranean diet on dry eye in obese hypertensive elderly. *Ir. J. Med. Sci.* **2023**, *192*, 3151–3161. [CrossRef] [PubMed]
35. Chakravarthy, U.; Williams, M. The royal college of ophthalmologists guidelines on AMD: Executive summary. *Eye* **2013**, *27*, 1429–1431. [CrossRef]

36. Munch, I.C.; Linneberg, A.; Larsen, M. Precursors of age-related macular degeneration: Associations with physical activity, obesity, and serum lipids in the inter99 eye study. *Investig. Ophthalmol. Vis. Sci.* **2013**, *54*, 3932–3940. [CrossRef]
37. Loprinzi, P.D.; Herod, S.M.; Cardinal, B.J.; Noakes, T.D. Physical activity and the brain: A review of this dynamic, bi-directional relationship. *Brain Res.* **2013**, *1539*, 95–104. [CrossRef]
38. Wang, M.T.; Muntz, A.; Wolffsohn, J.S.; Craig, J.P. Association between dry eye disease, self-perceived health status, and self-reported psychological stress burden. *Clin. Exp. Optom.* **2021**, *104*, 835–840. [CrossRef] [PubMed]
39. Dougherty, B.E.; Cooley, S.S.; Davidorf, F. The relationship between perceived stress and self-reported visual function in patients with neovascular age-related macular degeneration (AMD). *Investig. Ophthalmol. Vis. Sci.* **2015**, *56*, 1370.
40. Risner, D.; Ehrlich, R.; Kheradiya, N.S.; Siesky, B.; McCranor, L.; Harris, A. Effects of exercise on intraocular pressure and ocular blood flow: A review. *J. Glaucoma* **2009**, *18*, 429–436. [CrossRef]
41. Loprinzi, P.D.; Swenor, B.K.; Ramulu, P.Y. Age-related macular degeneration is associated with less physical activity among US adults: Cross-sectional study. *PLoS ONE* **2015**, *10*, e0125394. [CrossRef]
42. Praidou, A.; Harris, M.; Niakas, D.; Labiris, G. Physical activity and its correlation to diabetic retinopathy. *J. Diabetes Its Complicat.* **2017**, *31*, 456–461. [CrossRef]
43. Yan, X.; Han, X.; Wu, C.; Shang, X.; Zhang, L.; He, M. Effect of physical activity on reducing the risk of diabetic retinopathy progression: 10-year prospective findings from the 45 and up Study. *PLoS ONE* **2021**, *16*, e0239214. [CrossRef]
44. Dirani, M.; Crowston, J.; van Wijngaarden, P. Physical inactivity as a risk factor for diabetic retinopathy? A review. *Clin. Exp. Ophthalmol.* **2014**, *42*, 574–581. [CrossRef]
45. Zhang, Q.; Jiang, Y.; Deng, C.; Wang, J. Effects and potential mechanisms of exercise and physical activity on eye health and ocular diseases. *Front. Med.* **2024**, *11*, 1353624. [CrossRef] [PubMed]
46. Schneider, S.H.; Khachadurian, A.K.; Amorosa, L.F.; Clemow, L.; Ruderman, N.B. Tenyear experience with an exercise-based outpatient life-style modification program in the treatment of diabetes mellitus. *Diabetes Care* **1992**, *15*, 1800–1810. [CrossRef]
47. Irvine, C.; Taylor, N.F. Progressive resistance exercise improves glycaemic control in people with type 2 diabetes mellitus: A systematic review. *Aust. J. Physiother.* **2009**, *55*, 237–246. [CrossRef]
48. Pollock, M.L.; Carroll, J.F.; Graves, J.E.; Leggett, S.H.; Braith, R.W.; Limacher, M.A.R.I.A.N.; Hagberg, J.M. Injuries and adherence to walk/jog and resistance training programs in the elderly. *Med. Sci. Sports Exerc.* **1991**, *23*, 1194–1200. [CrossRef] [PubMed]
49. Li, H.; Li, F.; Zhou, R.; Gao, K.; Liang, L.; Zhang, X. Aerobic exercise increases tear secretion and decreases inflammatory cytokines in healthy subjects. *Asia-Pac. J. Ophthalmol.* **2020**, *9*, 404–411. [CrossRef] [PubMed]
50. Bennitt, F.B.; Wozniak, S.; Causey, K.; Spearman, S.; Okereke, C.; Garcia, V.; Hashmeh, N.; Ashbaugh, C.; Abdelkader, A.; Abdoun, M.; et al. Global, regional, and national burden of household air pollution, 1990–2021: A systematic analysis for the Global Burden of Disease Study 2021. *Lancet* **2025**, *405*, 1167–1181. [CrossRef]
51. World Health Organization. Ambient (Outdoor) Air Pollution. 2024. Available online: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health (accessed on 12 June 2025).
52. Diaz, E.; Smith-Sivertsen, T.; Pope, D.; Lie, R.T.; Diaz, A.; McCracken, J.; Arana, B.; Smith, K.R.; Bruce, N. Eye discomfort, headache and back pain among Mayan Guatemalan women taking part in a randomised stove intervention trial. *J. Epidemiol. Community Health* **2007**, *61*, 74–79. [CrossRef]
53. Shin, J.; Lee, H.; Kim, H. Association between exposure to ambient air pollution and age-related cataract: A nationwide population-based retrospective cohort study. *Int. J. Environ. Res. Public Health* **2020**, *17*, 9231. [CrossRef]
54. Millen, A.E.; Dighe, S.; Kordas, K.; Aminigo, B.Z.; Zafron, M.L.; Mu, L. Air pollution and chronic eye disease in adults: A scoping review. *Ophthalmic Epidemiol.* **2024**, *31*, 1–10. [CrossRef]
55. Wang, W.; He, M.; Li, Z.; Huang, W. Epidemiological variations and trends in health burden of glaucoma worldwide. *Acta Ophthalmol.* **2019**, *97*, e349–e355. [CrossRef] [PubMed]
56. Chua, S.Y.; Khawaja, A.P.; Morgan, J.; Strouthidis, N.; Reisman, C.; Dick, A.D.; Khaw, P.T.; Patel, P.J.; Foster, P.J.; UK Biobank Eye and Vision Consortium. The relationship between ambient atmospheric fine particulate matter (PM2. 5) and glaucoma in a large community cohort. *Investig. Ophthalmol. Vis. Sci.* **2019**, *60*, 4915–4923. [CrossRef] [PubMed]
57. Hetland, R.B.; Cassee, F.R.; Låg, M.; Refsnes, M.; Dybing, E.; Schwarze, P.E. Cytokine release from alveolar macrophages exposed to ambient particulate matter: Heterogeneity in relation to size, city and season. *Part. Fibre Toxicol.* **2005**, *2*, 4. [CrossRef]
58. Vohra, K.; Vodonos, A.; Schwartz, J.; Marais, E.A.; Sulprizio, M.P.; Mickley, L.J. Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. *Environ. Res.* **2021**, *195*, 110754. [CrossRef] [PubMed]
59. Kappos, A.D.; Bruckmann, P.; Eikmann, T.; Englert, N.; Heinrich, U.; Höppe, P.; Koch, E.; Krause, G.H.; Kreyling, W.G.; Rauchfuss, K.; et al. Health effects of particles in ambient air. *Int. J. Hyg. Environ. Health* **2004**, *207*, 399–407. [CrossRef]
60. Holguin, F. Traffic, outdoor air pollution, and asthma. *Immunol. Allergy Clin. N. Am.* **2008**, *28*, 577–588. [CrossRef]
61. Chua, S.Y.; Khawaja, A.P.; Desai, P.; Rahi, J.S.; Day, A.C.; Hammond, C.J.; Khaw, P.T.; Foster, P.J. The association of ambient air pollution with cataract surgery in UK biobank participants: Prospective cohort study. *Investig. Ophthalmol. Vis. Sci.* **2021**, *62*, 7. [CrossRef]

62. Grant, A.; Leung, G.; Aubin, M.J.; Kergoat, M.J.; Li, G.; Freeman, E.E. Fine particulate matter and age-related eye disease: The Canadian longitudinal study on aging. *Investig. Ophthalmol. Vis. Sci.* **2021**, *62*, 7. [CrossRef]
63. Chua, S.Y.; Warwick, A.; Peto, T.; Balaskas, K.; Moore, A.T.; Reisman, C.; Desai, P.; Lotery, A.J.; Dhillon, B.; Khaw, P.T.; et al. Association of ambient air pollution with age-related macular degeneration and retinal thickness in UK Biobank. *Br. J. Ophthalmol.* **2022**, *106*, 705–711. [CrossRef]
64. Saha, A.; Kulkarni, P.K.; Shah, A.; Patel, M.; Saiyed, H.N. Ocular morbidity and fuel use: An experience from India. *Occup. Environ. Med.* **2005**, *62*, 66–69. [CrossRef]
65. Fullerton, D.G.; Bruce, N.; Gordon, S.B. Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. *Trans. R. Soc. Trop. Med. Hyg.* **2008**, *102*, 843–851. [CrossRef]
66. Nita, M.; Grzybowski, A. Smoking and eye pathologies. A systemic review. Part I. Anterior eye segment pathologies. *Curr. Pharm. Des.* **2017**, *23*, 629–638. [CrossRef]
67. Asiamah, R.; Ampo, E.; Ampiah, E.E.; Nketia, M.O.; Kyei, S. Impact of smoking on ocular health: A systematic review and meta-meta-analysis. *Eur. J. Ophthalmol.* **2025**, *35*, 1506–1518. [CrossRef]
68. Pokhrel, A.K.; Smith, K.R.; Khalakdina, A.; Deuja, A.; Bates, M.N. Case–control study of indoor cooking smoke exposure and cataract in Nepal and India. *Int. J. Epidemiol.* **2005**, *34*, 702–708. [CrossRef] [PubMed]
69. Raju, P.; George, R.; Ramesh, S.V.; Arvind, H.; Baskaran, M.; Vijaya, L. Influence of tobacco use on cataract development. *Br. J. Ophthalmol.* **2006**, *90*, 1374–1377. [CrossRef] [PubMed]
70. Khan, J.C.; Thurlby, D.A.; Shahid, H.; Clayton, D.G.; Yates, J.R.W.; Bradley, M.; Moore, A.T.; Bird, A.C. Smoking and age related macular degeneration: The number of pack years of cigarette smoking is a major determinant of risk for both geographic atrophy and choroidal neovascularisation. *Br. J. Ophthalmol.* **2006**, *90*, 75–80. [CrossRef] [PubMed]
71. Gonçalves, R.B.; Coletta, R.D.; Silvério, K.G.; Benevides, L.; Casati, M.Z.; Da Silva, J.S.; Nociti, F.H. Impact of smoking on inflammation: Overview of molecular mechanisms. *Inflamm. Res.* **2011**, *60*, 409–424. [CrossRef]
72. Iho, S.; Tanaka, Y.; Takauji, R.; Kobayashi, C.; Muramatsu, I.; Iwasaki, H.; Nakamura, K.; Sasaki, Y.; Nakao, K.; Takahashi, T. Nicotine induces human neutrophils to produce IL-8 through the generation of peroxynitrite and subsequent activation of NF-κB. *J. Leucoc. Biol.* **2003**, *74*, 942–951. [CrossRef]
73. Moss, S.E.; Klein, R.; Klein, B.E. Incidence of dry eye in an older population. *Arch. Ophthalmol.* **2004**, *122*, 369–373. [CrossRef]
74. Altinors, D.D.; Akça, S.; Akova, Y.A.; Bilezikçi, B.; Goto, E.; Dogru, M.; Tsubota, K. Smoking associated with damage to the lipid layer of the ocular surface. *Am. J. Ophthalmol.* **2006**, *141*, 1016–1021. [CrossRef] [PubMed]
75. Thomas, J.; Jacob, G.P.; Abraham, L.; Noushad, B. The effect of smoking on the ocular surface and the precorneal tear film. *Australas. Med. J.* **2012**, *5*, 221. [CrossRef] [PubMed]
76. Sayin, N.; Kara, N.; Pekel, G.; Altinkaynak, H. Effects of chronic smoking on central corneal thickness, endothelial cell, and dry eye parameters. *Cutan. Ocul. Toxicol.* **2014**, *33*, 201–205. [CrossRef]
77. Xu, L.; Zhang, W.; Zhu, X.Y.; Suo, T.; Fan, X.Q.; Fu, Y. Smoking and the risk of dry eye: A Meta-analysis. *Int. J. Ophthalmol.* **2016**, *9*, 1480. [CrossRef]
78. Patel, S.; Tohme, N.; Gorrin, E.; Kumar, N.; Goldhagen, B.; Galor, A. Prevalence and risk factors for chalazion in an older veteran population. *Br. J. Ophthalmol.* **2022**, *106*, 1200–1205. [CrossRef]
79. Martheswaran, T.; Shmunes, M.H.; Ronquillo, Y.C.; Moshirfar, M. The impact of vaping on ocular health: A literature review. *Int. Ophthalmol.* **2021**, *41*, 2925–2932. [CrossRef] [PubMed]
80. Zheng, Y.; Wu, X.; Lin, X.; Lin, H. The prevalence of depression and depressive symptoms among eye disease patients: A systematic review and meta-analysis. *Sci. Rep.* **2017**, *7*, 46453. [CrossRef]
81. Galor, A.; Feuer, W.; Lee, D.J.; Florez, H.; Faler, A.L.; Zann, K.L.; Perez, V.L. Depression, post-traumatic stress disorder, and dry eye syndrome: A study utilizing the national United States Veterans Affairs administrative database. *Am. J. Ophthalmol.* **2012**, *154*, 340–346. [CrossRef]
82. Van Der Vaart, R.; Weaver, M.A.; Lefebvre, C.; Davis, R.M. The association between dry eye disease and depression and anxiety in a large population-based study. *Am. J. Ophthalmol.* **2015**, *159*, 470–474. [CrossRef]
83. Basilious, A.; Xu, C.Y.; Malvankar-Mehta, M.S. Dry eye disease and psychiatric disorders: A systematic review and meta-analysis. *Eur. J. Ophthalmol.* **2022**, *32*, 1872–1889. [CrossRef] [PubMed]
84. Koçer, E.; Koçer, A.; Özsütçü, M.; Dursun, A.E.; Kirpinar, I. Dry eye related to commonly used new antidepressants. *J. Clin. Psychopharmacol.* **2015**, *35*, 411–413. [CrossRef]
85. Vehof, J.; Snieder, H.; Jansonius, N.; Hammond, C.J. Prevalence and risk factors of dry eye in 79,866 participants of the population-based Lifelines cohort study in the Netherlands. *Ocul. Surf.* **2021**, *19*, 83–93. [CrossRef]
86. Wen, W.; Wu, Y.; Chen, Y.; Gong, L.; Li, M.; Chen, X.; Yan, M.; Xiao, Z.; Sun, X. Dry eye disease in patients with depressive and anxiety disorders in Shanghai. *Cornea* **2012**, *31*, 686–692. [CrossRef]
87. Cui, B.; Guo, X.; Zhou, W.; Zhang, X.; He, K.; Bai, T.; Lin, D.; Wei-Zhang, S.; Zhao, Y.; Liu, S.; et al. Exercise alleviates neovascular age-related macular degeneration by inhibiting AIM2 inflammasome in myeloid cells. *Metabolism* **2023**, *144*, 155584. [CrossRef]

88. Tang, W.S.W.; Lau, N.X.M.; Krishnan, M.N.; Chin, Y.C.; Ho, C.S.H. Depression and eye disease—A narrative review of common underlying pathophysiological mechanisms and their potential applications. *J. Clin. Med.* **2024**, *13*, 3081. [CrossRef]
89. Galor, A.; Felix, E.R.; Feuer, W.; Shalabi, N.; Martin, E.R.; Margolis, T.P.; Sarantopoulos, C.D.; Levitt, R.C. Dry eye symptoms align more closely to non-ocular conditions than to tear film parameters. *Br. J. Ophthalmol.* **2015**, *99*, 1126–1129. [CrossRef] [PubMed]
90. Wolffsohn, J.S.; Wang, M.T.; Vidal-Rohr, M.; Menduni, F.; Dhallu, S.; Ipek, T.; Acar, D.; Recchioni, A.; France, A.; Kingsnorth, A.; et al. Demographic and lifestyle risk factors of dry eye disease subtypes: A cross-sectional study. *Ocul. Surf.* **2021**, *21*, 58–63. [CrossRef] [PubMed]