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Looking Ahead – How will the climate crisis impact eyecare?

EDUCATION

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ABSTRACT

Summary
The Royal College of Ophthalmologists has warned that the ongoing climate crisis poses a 'threat to eye health'. Currently, one in five of us will experience sight loss in our lifetime, but with numerous growing threats, sight loss is set to double by 2050. So, how much of this increase can be attributed to climate change? This article explores the mechanisms by which climate change contributes to ocular disease burden and argues that the medical community can act to stop its impact from materialising; whether it may be reducing single-use plastics to decrease global incidence of conjunctivitis, educating patients to result in fewer cataract cases or recycling equipment to reduce glaucoma prevalence.

Relevance
The doctors of the future will be managing the health implications of the climate crisis and also be the ones attempting to stop it. Knowing the ocular diseases which will become more clinically relevant and knowing how to practice sustainably should make better, more prepared clinicians. Additionally, by understanding the effects of the climate, they can advise patients on how they can protect their eyes from its effects, to slow the rising of sight loss in the UK.

Take home messages
The climate crisis results in ocular diseases ranging from uveitis to conjunctivitis to acute and open angle glaucoma via. multiple mechanisms. Patients can preserve their eye health, for example through the use of UV-protective sunglasses, or by consumption of an antioxidant-rich diet.
Healthcare results in 5% of the Earth's carbon footprint, making sustainable practise a necessity. Individually, we can prescribe dry powder rather than metered dose inhalers to have 10x less the carbon footprint and wear washable scrub hats to reduce unnecessary waste. On a wider scale, hospitals can change policy, minimise single-use plastic equipment usage and encourage telemedicine to cut emissions by greater amounts.

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One in five of us will experience sight loss in our liOne in five of us will experience sight loss in our lifetime, and cases are set to double by 2050.[1] This dramatic rise cannot be explained by ageing alone. This begs the question, why? Increasingly, evidence points towards the climate crisis as one driver of eye disease. The Royal College of Ophthalmologists has recognised climate change as a "threat to eye health",[2] a threat which is already evident in Southern Spain, where more than a third of eye disease is estimated to be linked to climate-related factors.[3]

For medical students and resident doctors of today, this is not a distant problem – it is a reality they will confront in their future practice. Despite the increasing global relevance of eye health, ophthalmology teaching in medical school has more than halved in the last two decades,[4] leaving many graduates with low confidence and feeling underprepared.[5] If climate change is reshaping disease patterns, medical education must evolve too to enable students to tackle healthcare problems of the future.

This article intends to spark a conversation about what is important for the next generation of doctors to know about eyecare and climate change:

(1) The ocular diseases becoming more prevalent due to the climate crisis
(2) How healthcare professionals can adapt their practice to reduce the burden of disease and their environmental footprint.

The climate crisis is not solely environmental nor political, it is also clinical, and the next generation of doctors should be equipped to rise to the challenge.

What ocular diseases are linked to the climate crisis?

Papers have shown that climate change results in altered disease patterns, infectious agents and mortality, which mostly results in adverse health outcomes,[6] but the overall impact in ophthalmology is less documented. The possible consequences of global warming, ultraviolet radiation and air pollution as part of the climate crisis have been explored by this article.

Global warming

Global temperatures have risen by 0.85ºc since the 1880s and are projected to rise by up to 4.8ºc by 2100 by the Intergovernmental Panel for Climate Change, with longer and more frequent heatwaves.[7] This dramatic rise in average temperature over our lifetimes will inevitably have an impact on eyecare, as multiple elements of eye physiology are affected by temperature. For example, ambient heat accelerates tear film evaporation[8] and increases the processing speed of retinal photoreceptors.[9]

All doctors should be able to identify ocular emergencies to prevent avoidable vision loss, making a potential rise in retinal detachment cases important to note. Tractional retinal detachment has been linked to "elevated outdoor temperatures" in the week preceding onset.[10] A "mean weekly temperature of 25ºc", compared with 15ºc, was linked to more than double the odds of tractional retinal detachment in those under 75 years. Other forms of retinal detachment showed no similar link, although a wider daily temperature range has been linked to increased rhegmatogenous retinal detachment.[11] Doctors should therefore remain alert to key risk factors that may heighten suspicion for these forms of detachment, including proliferative diabetic retinopathy, uveitis, retinal vein occlusion and sickle cell disease.[12]

Similarly, uveitis demonstrates some seasonal variation,[13] so studies have also explored its relationship with rising ambient temperatures.[14] One Chinese revealed that a 1ºc rise in regional temperature was associated with an additional 0.2% of the population developing uveitis, a figure equivalent to twice the yearly incidence seen in the UK.[15] Additional UK statistical data shows that since 2004, uveitis incidence has been steadily increasing, bar a fall during the pandemic, thought to reflect underdiagnosis[15] Therefore, if global temperatures do rise by 5ºc by the end of this century as some predictions suggest,[7] demand for uveitis services would be expected to increase substantially, requiring significant expansion to keep up.

In addition to altering disease patterns, global warming may also influence the pathogens responsible for infection. In the UK, higher temperatures have been associated with a greater proportion of gram-positive bacteria in microbial keratitis, whereas lower temperatures are linked to fungal infections.[16] Moreover, microbial keratitis demonstrates seasonal variation,[16,17] it is most common in summer, and the number of cases has been rising with each passing summer.[17] Clinicians therefore need to be especially vigilant for microbial keratitis in the summer months and healthcare providers should ensure their treatment guidelines are regularly updated to prevent incorrect antimicrobial selection.

Taken together, these findings suggest global warming is poised to alter both the burden and aetiology of several ocular diseases. Doctors should be particularly vigilant of the presentation and management of uveitis, retinal detachment and infectious keratitis. As these changes occur over many years, it is vital we are not caught off-guard by the warming effects of the globe on ocular health.

Ultraviolet Radiation

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The climate crisis will lead to ultraviolet radiation (UVR) exposure through many mechanisms.[18] Firstly, the ozone layer absorbs UVR heading towards Earth from space, reducing our exposure, however, due to use of aerosols containing ozone-toxic chemicals, damage to this UVR protective barrier has occurred. While recovery is projected in the most populated latitudes with these aerosols being outlawed, at the poles of the earth the ozone layer is degrading further. Secondly, the icecaps, which reflect UVR back into the atmosphere, are melting due to global warming, creating an even greater exposure in the Earth's atmosphere.[18] These factors, among others such as cloud cover, mean that our UVR exposure will change in the coming years, making it important to appreciate the impact of UVR on the eye.

One well-documented impact is the positive correlation between cataract prevalence and UVR exposure.[19] A study of 64,307 Aboriginal Australians found that those living in regions with a higher UVR exposure faced an increased risk of developing cataracts, with an earlier onset and poorer prognosis. A clear dose-response relationship was present across five levels of UVR exposure and was consistent across all age groups. This causal link between UVR and cataracts was later supported by a French study showing the same association.[20] As cataract surgery is the most common surgery performed in the NHS,[21] reducing UVR exposure, for example via. sunglasses, would be a simple but effective intervention to help prevent cataracts and ease pressure on finite healthcare resources.

The same French study also reported a statistically significant increase in age-related macular degeneration (AMD) cases with high UVR exposure compared to those with moderate exposure.[20] These findings are supported a cohort study in China which found that high UVR exposure and low ozone levels were associated with a 32% and 20% higher risk of AMD, respectively.[22] One proposed mechanism is the oxidative stress induced by UVR,[23] which leads to cellular damage in the retina. This is consistent with evidence showing that antioxidants have a protective effect against age-related eye disease,[24] making an antioxidant-rich diet a likely preventative measure.

Children, who accumulate "up to 80%" of their lifetime UVR exposure before adulthood,[23] are particularly vulnerable to these long-term effects. As greater doses of UVR is clearly linked to both cataracts and AMD, regions facing rising UVR levels may see their disease burden increase in the coming decades. Prioritising UVR protection against young eyes is therefore crucial. Simple measures, such as the use of UVR-blocking spectacles or antioxidant diets in high-risk children, including those with a positive family history or long-term steroid use, offers a low cost but powerful way to preserve ocular health for the future.

Air pollution

While rising levels of air pollution is a well-recognised aspect of the climate crisis, it is less widely appreciated that this relationship forms a positive feedback loop. Climate change, partially caused by air pollution, can also alter air pollutant levels, increasing surface-level ozone (O3) and atmospheric Particulate Matter (PM).[25] PM alone has been declared by the World Health Organisation as leading environmental threat to human health.[26]

The effect of these pollutants on ocular health has been explored, with evidence linking exposure to an increased risk of conjunctivitis.[27] A systematic review concluded that exposure to PM, O3, NO2 and SO3 are all associated with a higher incidence of conjunctivitis globally. Rising air pollution coincides with the globally rising allergic conjunctivitis cases,[28] making it key for primary care clinicians to be able to identify and manage this condition. Further study elaborates on this relationship, identifying humidity, female sex and childhood as additional risk factors increasing vulnerability to this effect of air pollution;[29] factors that clinicians should consider when making a diagnosis.

Beyond surface irritation and allergic conjunctivitis, air pollution may also affect the eye's vasculature, contributing to more serious ocular disease.[30] In a study of 4,607 participants, those with increased PM exposure at home had, on average, a 0.8 μm narrower central retinal artery, equivalent to the narrowing caused by 7 years of ageing. Narrowing of the central retinal artery may increase the risk of retinal hypoperfusion and central retinal artery occlusion, an acute condition requiring urgent recognition to prevent sight loss. These vascular changes also explain why PM exposure increases the risk of glaucoma without increasing intraocular pressure.[27,31] Acute glaucoma risk in particular is estimated to rise by 7% following acute PM exposure.[31]

Although air pollutants generally appear damaging to eye health, contrarian evidence suggests that surface level O3 may be protective against cataract formation.[27,32] However, these findings do originate from low-pollution, high income areas in South Korea, limiting generalisability. Further study is therefore needed, but worth exploring, to determine whether this potential preventative measure can be exploited to reduce the substantial resources which are committed to cataract treatment.[21]

Overall, air pollutants seem to be driving higher rates of ocular disease, including conjunctivitis, central retinal artery occlusion and glaucoma. Identifying and differentiating ocular emergencies from other

pathologies is therefore more crucial than ever to prevent sight loss in future populations. While surface-level ozone may have a protective role against cataracts, it does not negate the broader risks pollution poses to eye health, underscoring the urgency to control environmental pollutants for the sake of eye health.

The climate crisis challenges healthcare to change

Recognising the issue is the first step, resolving it is the second. As the climate crisis seems to create adverse effects in eyecare and beyond, we, as healthcare professionals need to stop it. This may appear to be an insurmountable challenge, considering multiple industries and daily human activity contributes to this process, but healthcare is in fact a large contributor to climate change. The healthcare sector alone comprises ~5% of global greenhouse gas emissions, through mechanisms such as manufacturing, single-use plastic waste and disposal of equipment.[33] Pharmaceutical products also often have energy-intensive manufacturing processes, which when disposed of, result in the contamination of soil.[33] Even the metered dose inhalers prescribed for asthma have a carbon footprint, causing the release of propellants which perpetuate global warming.[34]

Global healthcare needs to change to reduce its impact on the growing climate crisis, but is its negative environmental impact an inevitable consequence? The "Aravind Eye Hospital" in Chennai, India proves it is not. Miss Radhika Rampat, consultant ophthalmic surgeon and chair of the AECOS green working group (an international sustainability group) discussed the novel sustainable features of this hospital at length at a recent conference.[35] Having visited the facility, she recognised the various sustainable practises not done in the UK, including multiuse preoperative eye drops, recyclable surgical instruments and surgical gowns which go in the laundry instead of as waste. The result? Their cataract surgeries have just 5% of the carbon footprint compared to the same and most common procedure in the UK.[21,36]

Some ophthalmic procedures, such as intravitreal injections, are relatively energy-efficient; however, 77% of their carbon footprint arises from patient travel rather than the procedure itself.[37] Establishing satellite 'hubs' for treatment could therefore not only improve adherence to these sight-saving therapies, but also substantially reduce procedural emissions. The same principal underpins the case for greater use of tele-medicine in outpatient care, where many follow-up appointments can be managed effectively by telephone or video consultation, eliminating unnecessary journeys. Embracing these models offers a dual benefit: lowering healthcare's environmental footprint while simultaneously improving patient access and convenience.

Improvements are there to be made, we just need to care to make them.

How to be a sustainable medical student and resident doctor

As more junior members of the medical team, changing traditional hospital practice is near impossible, but these large-scale changes are not the only way to be sustainable clAs more junior members of the medical team, changing traditional hospital practice is near impossible, but these large-scale changes are not the only way to be sustainable clinicians. In our everyday practise we can be mindful of the equipment we use, for example limiting non-sterile glove use to when there is possible bodily fluid or chemical exposure and contamination risk; hand hygiene is suitable otherwise.[38] Additionally, in theatre, rather than using disposable scrub caps, juniors could bring and wash their own, just as many of the scrub team currently do.

Prescribing sustainably is another easy way to reduce healthcare's carbon footprint as an individual – the pharmaceutical industry produces 55% greater emissions than the automotive industry.[39] To prescribe sustainably is to be weary what is being prescribed to a patient, if they need it and whether they will even take the medicine, instead of storing it needlessly in a cupboard. Deprescribing and communication is crucial to preventing drug waste, with many patients currently receiving free, ineffective and unused medication, which is eventually discarded. The formulation of medications prescribed can also help the environment. Metered dose inhalers for asthma, as previously mentioned, contribute to global warming, however, if dry powder or soft mist inhalers are prescribed instead, they have the same effect but with a 10 times lower carbon footprint.[40] Similarly, when prescribing preservative free eye drops, they can now be dispensed in bottles rather than single-dose vials while maintaining a low contamination risk. Switching prescriptions to bottles would reduce plastic waste by 8 times and reduce energy usage during transportation by 9 times.[41]

Measures such as these can be identified and implemented by medical students or resident doctors easily, and on a larger scale through quality improvement projects, creating both a monetary and environmental impact. Sustainability starts by educating doctors how to practise sustainably, and as doctors of the future, medical students and residents have a crucial role to play.

How can patients cope with the health effects of the climate crisis?

The climate crisis and its effects are coming, as even if we do achieve sustainable practice, change takes time. So in the meantime, how can we stop patients from

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succumbing to the apparent increased risk our environment is creating? Preventative measures are needed. Adapting a patient's lifestyle can be an effective way to reduce the ever-increasing ocular health risks which a patient faces if done correctly. Evidence relating to diet, physical activity and sleep are summarised in Table 1 below, with their potential health effect alongside.

While these lifestyle interventions are beneficial to all patients, the greatest value would come from targeting this advice to high-risk patients, such as those with a positive family history, otherwise patients can become overwhelmed with health information. The lifestyle changes should be tailored to the condition which it has an impact on, with the most beneficial change seemingly being high fish, plant-based diets,[24,42] which should be accompanied using UVR-protective sunglasses.

CONCLUSION

The climate crisis is having a negative effect on eye health, causing disease ranging from conjunctivitis to uveitis to retinal detachment. As time passes, it is becoming increasingly clear that our environment is deteriorating, the warming effect inevitable, the pollution levels unavoidable and ultraviolet radiation multiplying. Now, therefore, it is time we prepare to expect the ocular sequelae of climate crisis in healthcare, focusing teaching and service provision toward the relevant conditions. However, the sequelae can still be stunted. Teaching about how to practice sustainably should begin in medical school, so students and doctors are mindful of the equipment they use, the medicines they prescribe and the waste which they produce. Reducing the impact of the climate crisis is possible, the blueprints exist from sustainable hospitals around the world, but an aligned healthcare system is needed to create it. Most people are aware of the problem, but now is the time to get them to act.

Lifestyle change	**Ocular Effect**
Mediterranean diet: • Plant-based, unprocessed food • Olive oil • Low red meat	Protective against: Age-related macular degeneration[24] Diabetic retinopathy (in diabetics)[24]
Pescatarian Diet: • High in fish • Plant-based foods	Protects against: Age-related macular degeneration[42] Cataracts[42]
High red meat consumption	Increased risk of age-related eye disease[42]
Aerobic exercise	Protective against: Diabetic retinopathy (in diabetics)[43,44]
Time spent outdoors	Protects against myopia (short-sightedness) in children[45]
Short sleep duration	Increased risk of cataracts[46] Increased glaucoma risk[47]
Excessive and daytime sleeping	Increased risk of diabetic retinopathy[46] Increased glaucoma risk[47]

Table 1: *Table summarising the potential impact of various lifestyle changes on the risk of developing different eye diseases.*

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