elektron eye technology

The dangers of blue light

What is it and how can we protect against its threat?

Contents

Introduction

A growing body of medical research is beginning to focus on the role played by harmful blue light in damaging the eye, leading to conditions like age-related macular degeneration (AMD).

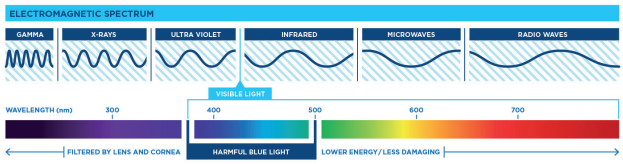
This has been prompted by two global factors: an ageing population and a younger generation making regular, heavy use of blue light-emitting technology.

In this whitepaper we will examine in greater detail the effects of blue light, the eye's natural resistance to it, and how that resistance can be bolstered. Particularly close attention will be paid to the role of technology and blue light, specifically:

- The increasing use of blue light-emitting technology in society today, and how drastically different our lives are from previous generations in this respect.
- How young people are particularly vulnerable to the harmful effects of blue light due to their unprecedented levels of exposure.
- What we know about the burden this places upon healthcare services, and the stance of various public health bodies on the issue.
- The work being done by the technology industry to reduce the amount of blue light produced by their products.
- The proactive steps that can be taken by patients and eye care professionals to mitigate the harmful impact of blue light and protect against the risk of developing AMD in future.

What do we mean by 'blue light?'

When we refer to 'blue light,' we are simply describing a specific colour within the spectrum of 'visible light' which can be picked up by our eyes. The visible light spectrum extends from 380-780 nanometres (nm).



Blue light within the spectrum of visible light on the electromagnetic spectrum (© Kemin Industries, Inc. Image used with permission).

Shorter wavelengths emit more energy, and each different wavelength is classified using a specific colour. All light contains blue light. Even the sun, the biggest source of light on Earth, contains it, which is what makes the sky appear blue to us when air molecules react to those high-energy blue wavelengths and scatter.

Why, then, should such a ubiquitous light source be a cause for concern? To answer that, we need to examine the process by which light interacts with the human eye, as shown in this breakdown by Dick Roberts, Ph.D, on behalf of Kemin Industries.

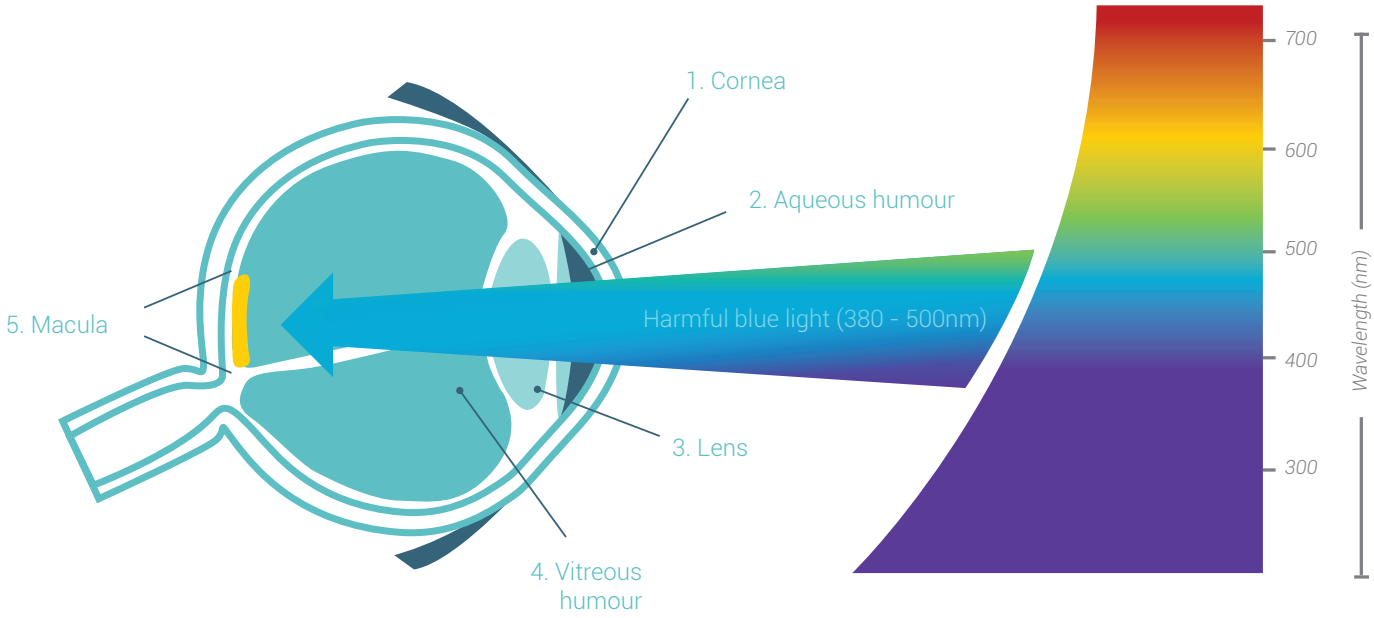
Light hits the eye and proceeds to pass through the various structural parts that form it, as follows:

1. The cornea absorbs short, energetic wavelengths of ultraviolet light.
2. Next, the aqueous humour absorbs infrared light wavelengths.
3. The lens then absorbs longer, lower-energy ultraviolet wavelengths.
4. The vitreous humour absorbs more infrared light which passed the aqueous humour.
5. Finally, visible light reaches the macula, right at the back of the eye.

> The macula receives all visible light, including high-energy blue light, between 380 and 500nm.

While there are some beneficial effects of blue light consumption – including helping to regulate the body's circadian rhythm – this light also has the greatest potential to cause harm.

Research commissioned by Essilor in 2008, in association with the Paris Vision Institute, identified blue light with a wavelength of 415-455nm as the biggest contributor to retinal cell death.



The path taken by harmful blue light through the lens to the macula

Blue light and AMD

Blue light exposure is undoubtedly a contributing factor to the development of AMD which is now the leading global cause of blindness, with 196 million people worldwide predicted to be affected by the condition by 2020.

The eye's natural defence against retinal cell death is largely found within the areas of the macula which directly handle exposure to visible light. It is here that antioxidant enzymes and molecules prevent harmful reactive oxygen species and free radicals from forming.

Composed of the antioxidant carotenoids lutein and zeaxanthin, macular pigment, in particular, forms a preventative barrier between the macula's photoreceptors and harmful blue light. Macular pigment optical density (MPOD) is the value used in eye health to determine the level of an individual's protection from blue light and the risk of AMD.

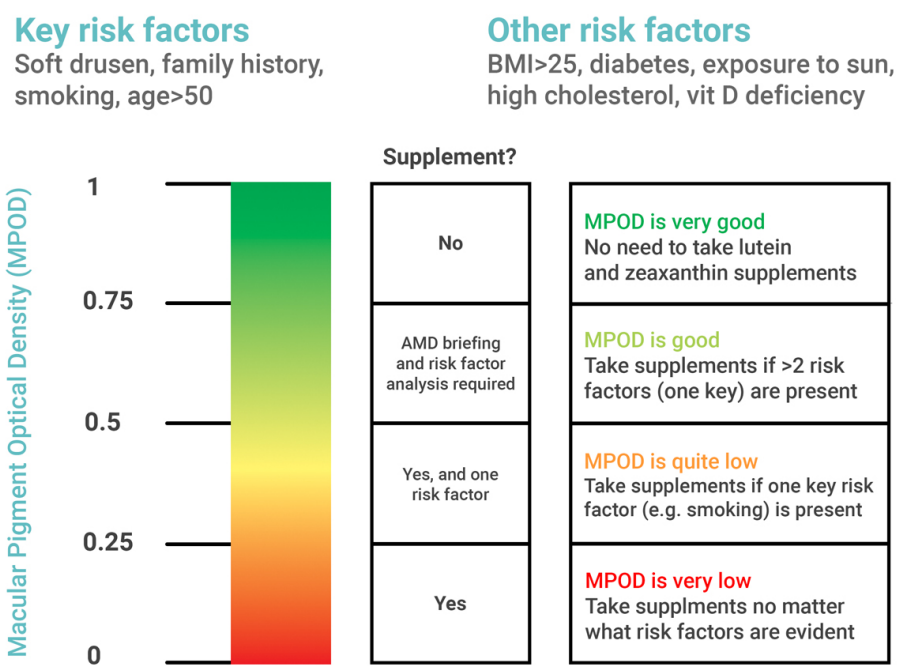
Research by Wooten and Hammond (2002), aggregated data from subjects across the US to determine that 43% of adults had a macular pigment optical density (MPOD) of less than 0.2 optical density units (ODU) and around 16% had an MPOD of <0.1.

Work conducted by Howells et al in 2013 suggested an average Caucasian MPOD of 0.33, compared with an average MPOD in Asians of 0.43. If these averages are considered alongside the results from Wooten and Hammond's study, above, the MPOD value (<0.2) of the 43% of aggregated US subjects is dangerously low.

An MPOD value of less than 0.25 is generally accepted as 'very low and 0.25-0.5 as 'quite low', thus the MPOD data cited above indicates that a large number of Caucasian and Asian subjects have limited protection against blue light and are, as a result, at real risk of developing AMD in future.

Although such MPOD categories are broadly useful in identifying those individuals at risk of AMD, they must be considered alongside a more detailed appraisal of a number of different risk factors, such as smoking, diet, family history, and more. We introduced a number of key non-modifiable and modifiable risk factors in our whitepaper *Age-related macular degeneration: the case for early screening.*

The commonly accepted key risk factor for AMD is age. The condition largely affects over-50s and some countries are taking steps to promote a proactive approach to screening to identify those at risk of or suffering from AMD within these sectors of the population. However, changing societal trends are now putting a new level of strain on a far wider social demographic.



MPOD values by levels of risk

The key macular degeneration risk factors in relation to MPOD values

Technologies emitting harmful blue light are now prevalent in society

Blue light's rising prevalence in society

Light from the sun contains around 25-30% blue light. While this can potentially present a problem for those who spend a large amount of time exposed to the sun without eye protection, it was not a significant enough threat to constitute a health problem for previous generations.

Light from light-emitting diodes (LEDs) and compact fluorescent lights (CFLs), however, contains around 35% and 25% blue light respectively. This type of light is typically emitted from devices like TVs, monitors, tablets and smartphones, and all of these are enjoying an enormous rise in popularity, to the point of saturation in many global markets.

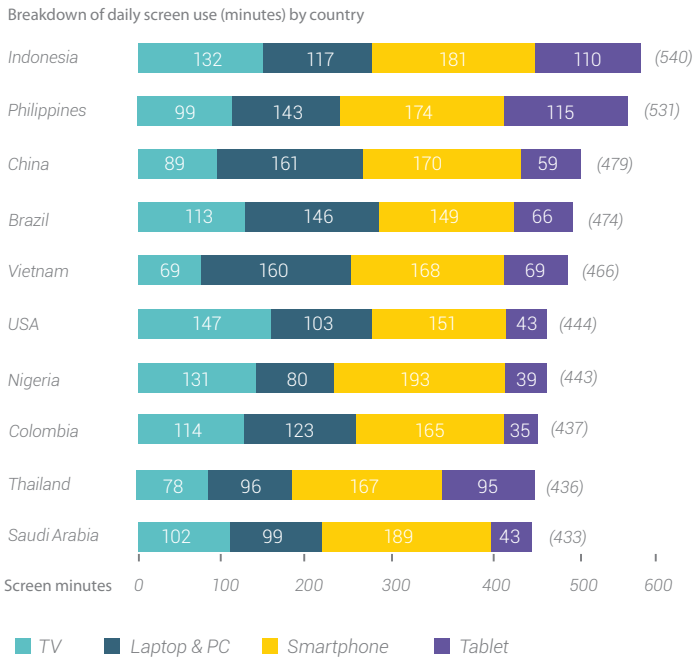
Telecommunications research indicates that, in the UK alone, 80.9% of the population will own a smartphone by the end of 2017. This is a steep rise from 2010, when it was around just 20%.

In 2016, Deloitte published research, *There's no place like phone: Consumer usage patterns in the era of peak smartphone,* indicating that almost half of 18-24 year olds check their phones during the night, not only interfering with the circadian rhythm, but also giving their eyes a sharp dose of blue light at a time when they should be most protected from it.

Factoring in other sources of blue light, it is estimated that by 2020, 90% of our total exposure to light will come from artificial means, such as LEDs and CLFs.

In 2014, research indicated that, split across TV, computer, smartphone and tablet use, our total time per day spent looking at screens is reaching dramatically high levels.

The top global consumers of harmful blue light were:



Of particular interest here is the number of Asian countries exposed to high levels of blue light. As discussed in one of our previous whitepapers on AMD, those of Asian heritage, especially women aged 40 to 79, are at particular risk of developing the condition.

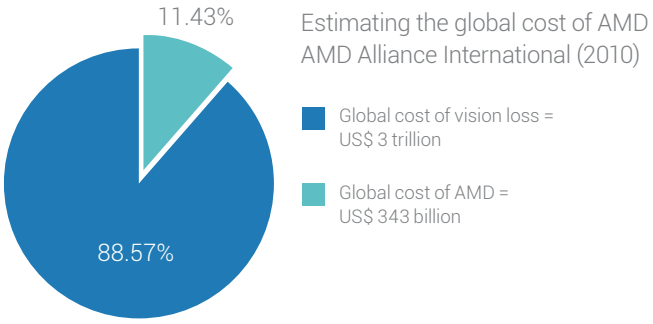
Combined with an ageing global population, such levels of blue light exposure are likely to create a heavy burden on healthcare systems across the world.

The healthcare burden of blue light

A 2006 review of the financial burden of AMD, entitled *The burden of age-related macular degeneration,* attempted to collate the direct and indirect medical costs of AMD. One of its conclusions was that zinc and antioxidant supplementation for non-exudative (dry) AMD and laser photocoagulation treatments are cost-effective, and that photodynamic therapy can be cost-effective in some patients.

This is supported by more recent data, published in 2010 by AMD Alliance International (AMDAI), stressing the importance of finding cost-effective treatments.

In the first ever attempt to estimate the overall global cost of AMD, AMDAI put the cost at US$343 billion, a significant portion of the nearly US$3 trillion vision loss healthcare costs worldwide.



AMD costs are already a global burden and will grow unless preventative action is taken.

Should these costs continue, such levels of expenditure will disproportionately impact developed nations with high life expectancy and already elevated healthcare bills.

These costs are likely to rise significantly by 2020 without a concerted global response, due to factors such as:

- The current lack of preventative screening programmes
- The production and distribution of visual aids
- Patients being forced out of the workforce due to AMD
- The effects of non-patients leaving the workforce to become carers

What are tech companies doing to help?

With little regulatory oversight controlling the amount of blue-violet light devices are allowed to emit, tech companies themselves are awakening to the need for self-regulation, albeit relatively slowly.

In a paper published in the Progress in Retinal and Eye Research journal in 2004, Margrain et al recommended significant further work was required to evaluate the effectiveness of blue-blocking filters, whether as eyewear or attachments for device screens themselves.

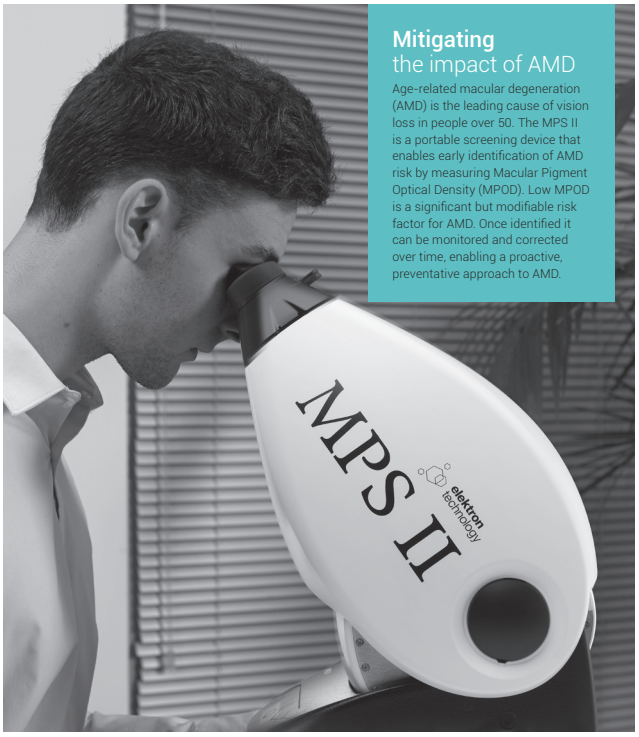
Software solutions to the problem of increasing blue light exposure include desktop apps which adjust the hue of the screen in line with the user's location and the time of day. Variants of these apps are available for most commonly-used digital platforms and smartphone brands.

What is interesting to note is that, with only a few exceptions, the development of both hardware and software solutions to the problem of blue light exposure comes predominantly from third-party sources.

How can we protect ourselves?

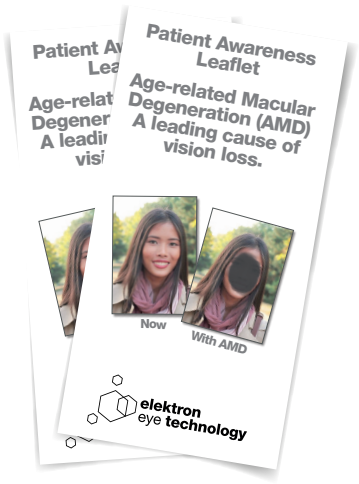
Due to the relatively slow response to the blue light issue from technology companies, the responsibility of controlling or reducing blue light intake falls to individual users themselves. Here, eye care professionals can play a pivotal role in educating and advising patients to make positive choices.

There are now ways for eye care professionals to identify people in the communities they serve who might be at an elevated risk of AMD. Age is an obvious factor, but gender also plays a proven role, with more women than men developing the condition; ethnic background is an indicator, too (with White and Asian populations particularly susceptible to AMD risk), while younger adults exposed to high levels of blue light in their daily lives should certainly not be ruled out.



Screening to detect low macular pigment optical density (MPOD) helps enable a proactive response to AMD risk

Using information such as this, it is possible to promote a programme of early screening among at-risk groups. Equipment like the MPS II is important here. Screening macular pigment levels is a scientifically validated method of detecting one of AMD's most significant and modifiable risk factors early, namely low MPOD.



Even where no AMD (or a low possibility of developing AMD) is detected, engaging with the community allows eye care professionals to promote supplementation to counter factors which contribute to its development further down the line.

Antioxidant supplements, along with zinc supplements, have been shown to reduce the risk of early AMD progressing to advanced AMD by 25-30%, according to the 2001-2013 AREDS study.

In patients with low levels of lutein and zeaxanthin, supplements containing these carotenoids can cut the risk of AMD progression by a further 10% to 20% respectively.

Of course, supplementation should not be seen as a primarily reactive measure. The elevated risk of AMD to future generations comes in no small part from our rapidly elevated intake of blue light not being matched by an increased intake of lutein and zeaxanthin to boost MPOD.

Regularly taking supplements containing these carotenoids will raise one's MPOD, preventing more harmful blue light from damaging the photoreceptors in the macula. Such a proactive approach will help ensure robust eye health, even in a world where blue light exposure may be inevitable.

Taking supplements raises MPOD levels

When it comes to the dangers of prolonged blue light exposure, however, education is the eye care professional's greatest asset. This is especially true for parents with young children.

Educating parents on the dangers of excessive blue light exposure to young, developing eyes can help protect not just their mood, sleep pattern and attention span, but also their vision in the long term. Placing curfews on screen use or fitting blue light filters to devices (where possible) will have lasting beneficial effects.

Conclusion: A vision for the future

The principal challenge posed by combatting the harmful effects of blue light is its near omnipresence in society. Whether engaging with a highly pervasive media or being constantly exposed to office lighting, our intake of harmful blue light with a wavelength of 415-455nm looks unlikely to decrease.

A large part of this is down to evolving social trends. The market penetration of smartphone devices and a shift towards an office-based service economy are just two examples of what drives this change.

However, these changes, and the increased blue light exposure that comes with them, have not been matched by adjustments to our diet which might increase our intake of lutein and zeaxanthin, proactively raising our MPOD and thus our protection against AMD.

This might change over time, but the facts of our current situation indicate that:

- While all excessive light exposure is harmful to the eyes, past generations simply have not been exposed to the same degree of intrusive light as the current one.
- High-energy, short-wavelength blue light is making up an increasing proportion of our daily light intake.
- We are approaching market saturation of blue light-emitting devices, and we are spending increasing amounts of time using them.
- Blue light has been linked to retinal cell death and is believed to be a contributing factor to the development of AMD.
- Tech companies are under no regulatory pressure to limit the amount of blue light their devices emit.

With this in mind, eye care professionals have an important role to play in promoting early screening, supplementation and education in order to combat the risk of AMD amongst both this generation, and those yet to come.

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t: +44 (0)1223 371000 **e:** info@elektroneyetechnology.com **w:** www.elektron-eye-technology.com