Review

Effects of blue light blocking glasses on visual performance, sleep, and neuroendocrine regulation: A narrative review

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Abstract

Blue light blocking glasses are being actively marketed as a non-pharmacological approach to lessen the negative impact of the exposure to artificial light and screen-based devices in the evening. Their mechanism is grounded on the sensitivity of melanopsin-containing intrinsically photosensitive retinal ganglion cells to short wavelength light which alters circadian timing, melatonin release, alertness, and associated neuroendocrine pathways. This narrative review assesses the implications of blue light blocking glasses on sleep, circadian regulation, visual performance, digital eye strain, neuroendocrine and neurophysiological and relates them to the bigger picture of current artificial light exposure. The evidence provided indicates that these glasses offer the best biological justification to the evening wear as far as sleep and circadian physiology are concerned. According to several studies exposure to short-wavelength light before bedtime can be reduced to mitigate the suppressive effect of melatonin, facilitate circadian synchrony, and have a modest effect on sleep initiation or sleep quality, especially in persons with insomnia or delayed sleep phase disorder. Conversely, there is inconsistent evidence of digital eye strain and visual performance. Other studies have found less subjective eye fatigue, and higher visual comfort, but randomized controlled trials have found no, or minimal, clinically meaningful advantage relative to conventional lenses. There is also preliminary evidence that it may have neuroendocrine and neurophysiological consequences, such as changes in melatonin responses and brainwave activity, although these effects are not well-studied. The concept of blue light-blocking glasses can be seen as a highly feasible addition to a broader approach to light management, rather than a complete solution to sleep or visual and cognitive well-being.

Keywords: Blue light blocking glasses, circadian rhythm, melatonin, digital eye strain, sleep quality

1. Introduction

Artificial light exposure has increased considerably over the past decades, especially with the widespread use of LED screens. Blue light corresponds to wavelengths around 400–490 nm and is considered higher energy light compared with other visible wavelengths, with disproportionate biological effects (Chang *et al.*, 2015; Gringras *et al.*, 2015). This part of the visible spectrum preferentially activates intrinsically photosensitive retinal ganglion cells (ipRGCs), which contain melanopsin and project to the suprachiasmatic nucleus, the main regulator of the circadian rhythm (Cajochen *et al.*, 2011; Chellappa *et al.*, 2011). Blue light exerts its biological effects primarily through activation of melanopsin-containing intrinsically photosensitive retinal ganglion cells (ipRGCs). These cells function independently of rods and cones and are specifically tuned to short-wavelength light (~480 nm). Upon activation, ipRGCs transmit signals via the retinohypothalamic tract to the suprachiasmatic nucleus (SCN), the central circadian pacemaker. The SCN then modulates downstream autonomic and endocrine pathways, ultimately inhibiting pineal melatonin

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production. This non-visual photoreception pathway explains why light exposure can alter circadian rhythms even in the absence of conscious visual perception.(Cajochen *et al.*, 2011; Chellappa *et al.*, 2011)

Melatonin is a key neuroendocrine hormone that signals the onset of biological night and promotes sleep initiation. Under normal physiological conditions, melatonin secretion follows a circadian rhythm regulated by the suprachiasmatic nucleus (SCN) of the hypothalamus (Cajochen *et al.*, 2011; Chellappa *et al.*, 2011). In the absence of light, retinal input to the SCN decreases, allowing activation of the pineal gland through a multisynaptic pathway involving the paraventricular nucleus and sympathetic innervation. This results in increased nocturnal melatonin synthesis and release, typically beginning in the evening (dim light melatonin onset) and peaking during the night. Melatonin acts as an internal signal that synchronizes sleep–wake cycles, lowers core body temperature, and promotes sleep propensity.

Nighttime activation of these non-visual pathways is linked to melatonin suppression, delayed circadian timing, and changes in sleep architecture (Cajochen *et al.*, 2011; Figueiro *et al.*, 2011; Chang *et al.*, 2015). Experimental work has shown that evening exposure to LED-backlit screens can delay sleep onset, shorten sleep duration, and reduce next day alertness (Chellappa *et al.*, 2011; Chang *et al.*, 2015), particularly when exposure happens in the hours right before bedtime.

At the same time, prolonged screen use is strongly associated with digital eye strain (DES), which commonly presents as visual fatigue, dry eyes, headaches, blurred vision, and reduced visual performance (Rosenfield, 2011). Recent systematic reviews suggest that DES becomes more common and more severe as daily screen time increases, especially when it exceeds about four hours per day (Sheppard and Wolffsohn, 2018; Kaur *et al.*, 2022; Mataftsi *et al.*, 2023).

Light exposure, particularly during the evening and nighttime, directly suppresses melatonin production through retinal photoreception pathways. Specialized intrinsically photosensitive retinal ganglion cells (ipRGCs), containing melanopsin, are highly sensitive to short-wavelength (blue) light and project directly to the SCN. When activated, these cells inhibit pineal melatonin synthesis, effectively signaling to the brain that it is still daytime. This results in delayed circadian phase, reduced sleepiness, and altered sleep architecture. Even relatively low-intensity light exposure from artificial sources can significantly attenuate melatonin secretion (Cajochen *et al.*, 2011; Chellappa *et al.*, 2011).

Under normal dark conditions, reduced retinal stimulation allows the suprachiasmatic nucleus (SCN) to activate the pineal gland, promoting melatonin release and sleep onset. In contrast, exposure to blue light activates melanopsin-containing ipRGCs, which signal the SCN to inhibit pineal melatonin secretion, delaying sleep initiation and altering circadian timing.

This narrative review aims to determine the impact of blue light blocking glasses on sleep and circadian physiology, visual performance, digital eye strain and neuroendocrine and neurophysiological regulation in the context of modern exposure to artificial light. This review has an integrative scope since it combines evidence of circadian, ophthalmologic, neurobiological domains that are frequently discussed independently throughout the existing literature. This approach is useful to fill an important gap in the literature, as past discourses often discussed only individual results or concentrated on commercial and consumer-related assertions without properly comparing mechanistic plausibility and clinical evidence. It helps to elucidate how far the benefits of blue light blocking glasses are really meaningful as well as the places where the evidence is still somewhat limited, mixed, or even preliminary by integrating both biological rationale with the current experimental and clinical evidence.

2. Historical novelty of artificial light at night

It has been proposed that use of digital devices, particularly around bedtime, is linked to disruptions in sleep, mediated through suppression of melatonin production and release (Chang *et al.*, 2015; Green *et al.*, 2017; Shechter *et al.*, 2018). Prior to the development of digital devices or artificial lighting, exposure to light came through sunlight, moonlight, fire, starlight (besides the Sun) or bioluminescence. On demand lighting came with the human ability to create and transport fire, later made more controllable through the use of flammable substances, such as tar and whale oil (Chellappa *et al.*, 2011; Gringras *et al.*, 2015).

The development of electric lighting increased human mastery over light yet again, drastically reducing the price per lumen hour and making nighttime shift work possible.

Since then, owing to innovation the cost has substantially decreased and the availability of artificial light has increased, making it a ubiquitous feature, even in the developing world. The development and commercialization of the blue light emitting diode allows light to consume a fraction of the energy of an incandescent bulb or phosphorescent tube, minimizing an important constraint on the availability of artificial light, allowing lights to be run from the power of a portable battery, a small solar panel, or for a generator to service a much larger number of light sources.

The ubiquity of artificial light has had numerous positive impacts for human development, allowing people to read and learn in the early morning or evening, allowing productive hours to be unconstrained, and enabling navigation and exploration at night and in inclement conditions.

While a positive development for humanity, the ubiquity of artificial light also carries some downsides, which can potentially be mitigated. Artificial light at night (ALAN), can disrupt several insect and animal species, and reduces the number of offspring they would otherwise have (Gringras *et al.*, 2015; Shechter *et al.*, 2018).

For humans, one technique of mitigation proposed is the use of blue light blocking glasses, as the part of the visual spectrum causing the greatest disruption to human circadian rhythms is the blue region of the spectrum. Early humans would not have experienced ALAN, aside from rare fires or bioluminescent organisms, alongside the minor light contributions of lightning, stars, planets and the moon. **Table 1** provides an overview of the luminance and spectral properties of major sources of natural and artificial light, showing the significant difference between the prehistoric light conditions and the current conditions of artificial light, particularly white LED sources with the blue peak.

In addition to sunlight and moonlight, early human exposure to light at night was extremely limited and largely dependent on rare natural sources. These included bioluminescent organisms, such as certain insects and marine species, as well as faint celestial light from stars and planets. While biologically relevant in evolutionary terms, the intensity of these light sources is orders of magnitude lower than that of modern artificial lighting and self-luminous digital displays. This contrast highlights the novelty of contemporary light environments and underscores the unprecedented magnitude of nocturnal light exposure experienced by modern humans. (Jia and Ionescu, 2015). **Table 2** summarizes the low-intensity natural sources of night light, such as bioluminescent organisms and celestial bodies, to highlight that there was a relative lack and low intensity of early human exposure to visibility at night versus present day artificial light sources.

Table 1. Comparison of Natural and Artificial Light Sources by Typical Luminance and Spectral Characteristics.

Light source	Typical luminance	Main wavelength range	Reference
Sunlight	100,000	Broad spectrum (400-700 nm)	(Chellappa *et al.*, 2011; Gringras *et al.*, 2015)
Moonlight	0.1-0.3	Reflected sunlight	(Gringras *et al.*, 2015)
Firelight	10-50	Predominant long wavelengths	(Chellappa *et al.*, 2011)
Incandescent bulb	100-500	Long wavelength dominant	(Gringras *et al.*, 2015)
Fluorescent lighting	300-500	Discrete spectral peaks	(Gringras *et al.*, 2015)
White LED lighting	300-1000	Prominent blue peak (450 nm)	(Chang *et al.*, 2015; Gringras *et al.*, 2015; Heo *et al.*, 2017)

Table 2. Low-Intensity Natural Nighttime Light Sources Relative to Early Human Light Exposure.

Source	Category	Intensity	Measurement	Reference
Bioluminescent insects	Biological	Visible light emission in complete darkness	Local luminance	(Martini and Haddock, 2017)
Marine bioluminescent organisms	Biological	Brief light flashes detectable at night	Relative Photos emission	(Martini and Haddock, 2017)
Firefly squid	Biological	Strong localized light	Qualitative emission intensity	(Johnsen, 2005)
Stars	Celestial	+1 to +6	Apparent magnitude	(Pogson, 1856)
Venus	Planet	4.6	Apparent magnitude	(Pogson, 1856)
Jupiter	Planet	2.7	Apparent magnitude	(Pogson, 1856)
Full moon	Celestial	12.6	Apparent magnitude	(Pogson, 1856)

Compared with these low-intensity natural light sources, modern artificial lighting and digital screens deliver substantially greater retinal illumination, particularly within the short-wavelength range most relevant to circadian and neuroendocrine regulation.

The artificial light spectrum also differs considerably from the light spectrum from the above highlighted natural sources, with the dominant component used to light interiors being the light emitting diode or fluorescent tube, with incandescent bulbs typically less common due to both efficiency regulations as well as higher unit and power costs relative to LEDs.

From a biological perspective, it is not just ambient light that has an effect, but critical biological processes are regulated by light sensitive opsin molecules in the eye (Heo *et al.*, 2017; Shechter *et al.*, 2018). These opsins, particularly melanopsin expressed in intrinsically photosensitive retinal ganglion cells (ipRGCs), play a central role in non-visual photoreception and are especially sensitive to short-wavelength blue light. Activation of these pathways influences circadian phase regulation, melatonin suppression, alertness, and neuroendocrine signaling, independently of conscious visual perception (Heo *et al.*, 2017; Shechter *et al.*, 2018).

For this reason, light entering the eye, such as light used to make images on screens (Table 3), has increased biological effect relative to ambient light. (Artigas *et al.*, 2012; Kaur *et al.*, 2022; Mataftsi *et al.*, 2023)

Table 3. Spectral and Luminance Characteristics of Typical Modern Screen-Based Devices.

Device	Display technology	Typical luminance	Main spectral characteristics	Reference
Smartphone	LED/OLED	400-1,000	Strong blue light component	(Chang *et al.*, 2015; Green *et al.*, 2017; Heo *et al.*, 2017)
Tablet	LED/OLED	400-600	Blue-enriched emission	(Chang *et al.*, 2015; Green *et al.*, 2017)
Laptop screen	LED-backlit LCD	250-400	Blue peak around 450 nm	(Chang *et al.*, 2015; Heo *et al.*, 2017)
Desktop monitor	LED-backlit LCD	300-500	Blue peak around 450 nm	(Chang *et al.*, 2015; Heo *et al.*, 2017)
Television	LED/OLED	300-800	Variable blue light emission	(Gringras *et al.*, 2015; Heo *et al.*, 2017)

3. The rationale for blue light-blocking glasses

Even though blue-light–filtering glasses are widely marketed and increasingly used, clinical evidence is still mixed. Some studies report meaningful improvements in symptoms like eye fatigue and subjective comfort (Lin *et al.*, 2017), while other well-designed randomized, double-masked trials show little to no difference compared with standard lenses (Singh, Downie and Anderson, 2021). Similar variability is seen in sleep-related outcomes: certain trials suggest better sleep onset or sleep quality with evening use of blue-blocking lenses (Esaki *et al.*, 2016; Shechter *et al.*, 2018), while other studies show smaller or more context-dependent effects (Ostrin, Abbott and Queener, 2017).

Short wavelengths are filtered by blue-blocking glasses, while hyperpolarized eyeglasses combine polarization and spectral filtering, potentially providing two advantages: lowering glare-induced strain and limiting the physiological disturbance caused by blue light. According to a few pilot experiments, polarized filters can minimize subjective weariness and enhance task-related concentration (Mercatelli,2023). However, there do not exist enough robust randomized controlled trials.

4. Sleep and the Circadian System

Blue light exposure in the evening can suppress melatonin and shift circadian timing, which can make it harder to fall asleep and may reduce sleep quality (Cajochen *et al.*, 2011; Figueiro *et al.*, 2011; Chang *et al.*, 2015). This has motivated the use of blue-blocking glasses as a simple, non-pharmacologic strategy, especially before bedtime. In a randomized controlled trial in patients with insomnia, blocking nocturnal blue light was associated with improvements in sleep-related outcomes (Shechter *et al.*, 2018). Similarly, studies in delayed sleep phase disorder suggest that wearing blue-blocking glasses in the evening may help advance circadian timing and support earlier sleep onset (Esaki *et al.*, 2016).

Blue light (approximately 460–480 nm) has a disproportionately strong effect on circadian regulation compared to other wavelengths, due to peak sensitivity of melanopsin-containing ipRGCs. Evening exposure to blue-enriched light from LED screens has been shown to suppress melatonin more effectively than longer wavelengths, delay sleep onset, and reduce next-day alertness. This has led to increasing interest in blue-light–blocking interventions, such as filtering glasses, which aim to reduce short-wavelength exposure and mitigate circadian disruption. While evidence is mixed, several studies suggest that reducing blue light exposure before bedtime may help preserve endogenous melatonin rhythms and improve sleep outcomes.(Chang *et al.*, 2015)

Other work has used physiological measures such as pupillary responses linked to ipRGC activity and sleep-related metrics to show that reducing short-wavelength exposure can influence circadian-related pathways (Ostrin, Abbott and Queener, 2017). Across studies, results generally support a relationship between evening light filtering and sleep/circadian outcomes, but effect sizes and consistency vary depending on population, timing of use, and the specific lens properties.

Randomized trials suggest that the use of blue-light–blocking glasses in the evening is associated with modest improvements in sleep onset latency and sleep quality, particularly in patients with insomnia or delayed sleep phase disorder. (Esaki et al., 2016; Shechter et al., 2018). However, effect sizes vary across studies and are influenced by timing of use and individual circadian profiles.

5. Performance and Visual Strain

Digital eye strain is considered a multifactorial problem. In addition to long screen time, factors like reduced blink rate, glare, and sustained near-focus demands can contribute to discomfort and reduced visual performance (Rosenfield, 2011). Trials evaluating blue-light–filtering lenses for DES show inconsistent results. For example, Lin et al. reported that short wavelength blocking glasses reduced symptoms of eye fatigue after screen exposure (Lin et al., 2017). In contrast, Singh et al. found no clinically meaningful reduction in eye strain in a double-masked randomized trial comparing blue-blocking lenses versus control lenses during extended screen use (Singh et al., 2021).

Beyond filtering, polarization has been proposed as another way to improve visual comfort by reducing glare and scattered light, which may matter in bright environments or situations with strong reflections (Mercatelli, 2023). There is also emerging evidence that blue-light–blocking lenses may improve contrast sensitivity in some settings, which could potentially translate into a more comfortable visual experience for screen users (Saleem et al., 2025). Overall, the current literature suggests possible benefits for some users, but effects are not consistent across studies, and the "best" lens design for DES remains uncertain.

Overall, randomized controlled trials show inconsistent or minimal benefit of blue-light–blocking lenses on digital eye strain. While some studies report subjective improvements in visual comfort, well-designed trials have demonstrated no significant difference compared with standard lenses (Lin et al., 2017; Singh et al., 2021), suggesting that factors such as screen time, blink rate, and ergonomics may play a more dominant role.

6. Neuroendocrine and brain system

Light exposure influences more than sleep timing, it can also affect neuroendocrine signals and brain activity. Melatonin is the clearest example, since it is directly suppressed by evening light exposure, including light emitted from screens (Cajochen et al., 2011). Recent clinical evidence suggests that blue-light–blocking glasses can attenuate light-induced melatonin suppression in healthy adults, supporting a measurable endocrine effect of optical filtering (Onodera et al., 2025). Since serotonin is closely related to mood regulation and is also involved in pathways connected to circadian biology, it has been included in broader discussions about light, sleep, and mental health outcomes (Lam et al., 2016).

On the neurophysiology side, studies suggest that evening light exposure can alter markers of alertness and cognitive arousal (Chellappa et al., 2011). More recent EEG based work indicates that using light-filtering glasses may produce measurable changes in brainwave activity, including reduced frontal beta power compared with control conditions (Boere & Krigolson, 2024). Evidence regarding cognitive and neurophysiological effects of blue-light–blocking lenses remains limited. However, studies on blue light exposure itself have shown that short-wavelength light can increase alertness and modulate cognitive performance through effects on brain activity and circadian signaling (Chellappa et al., 2011). In contrast, emerging EEG-based studies suggest that light-filtering interventions may reduce markers of neural arousal, such as frontal beta activity, although findings remain preliminary and not yet consistent across populations (Boere & Krigolson, 2024). While these findings are still early and not yet consistent across all studies, they raise the possibility that optical interventions could influence both circadian biology and neural arousal, beyond purely visual symptoms.

7. Discussion

The findings of this narrative review indicate that the advantages of blue light-blocking glasses are biologically possible, though the strength of evidence varies due to differences in the effects. The most persuasive explanation is associated with circadian physiology and sleep, as short-wavelength light has an established role in inhibiting melatonin and modulating circadian timing by acting on melanopsin-containing intrinsically photosensitive retinal ganglion cells and downstream signaling to the suprachiasmatic nucleus (Cajochen et al., 2011; Chellappa et al., 2011). In this scenario, the blue light blocking glasses seem to have the best theoretical foundation when worn in the evening or prior to bedtime. This review includes experimental and clinical studies that recommend that the reduction of short-wavelength exposure can be useful to preserve endogenous melatonin rhythms, alleviate sleep disruption, and slightly ameliorate differences in sleep, especially in patients with insomnia or delayed sleep phase disorder (Chang et al., 2015; Esaki et al., 2016; Ostrin, Abbott and Queener, 2017; Shechter et al., 2018). Nevertheless, the benefits are not always so significant, since outcomes are not the same in all studies, and they seem to be dependent on the timing of exposure, the underlying circadian vulnerability, or the optical properties of the lenses (Chang et al., 2015; Gringras et al., 2015; Green et al., 2017).

A major advantage of the circadian argument is that it is backed by a specified physiological pathway as opposed to subjective symptom reporting. Previous studies have demonstrated that exposure to blue-enriched light (screens and LED-backlit devices in the evenings) can inhibit melatonin, enhance wakefulness, postpone the onset of sleep, and deteriorate the functioning of the next morning (Figueiro et al., 2011; Cajochen et al., 2011; Chellappa et al., 2011; Chang et al., 2015; Shechter et al., 2018; Heo et al., 2017). This renders application of optical filtering as a plausible biological intervention. Simultaneously, the reviewed literature does not back the generalized conclusion that all screen time is as detrimental as it is threatening or that all blue light blocking screens are capable of creating significant changes in the sleep of all users. Instead, it is more likely to be contextually dependent, with the strongest application in individuals who use digital devices at night, already have trouble with sleep-onset, or are particularly sensitive to circadian disruption by light (Esaki et al., 2016; Ostrin, Abbott and Queener, 2017; Shechter et al., 2018).

However, the data on digital eye strain and visual performance are less unanimous. Digital eye strain is generally accepted as a multifactorial issue, comprising low blink rate, high-near-focus, glare, accommodative stress, and ocular surface instability, as well as any potential spectral impact of emitted light (Rosenfield, 2011; Sheppard & Wolffsohn, 2018; Kaur et al., 2022; Mataftsi et al., 2023). This is a critical fact, since it implies that blue light can be just one of the factors, and not necessarily the one which can be dominant in most real-life scenarios. The studies incorporated in this review represent that complexity. Other researchers have stated that the subjective eye fatigue and visual comfort with short-wavelength filtering lenses are reduced, and some users can gain symptomatic benefit (Lin et al., 2017; Saleem et al., 2025). Nonetheless, controlled randomized studies, which have been better managed, have been unable to find clinically significant differences between blue-blocking and regular glasses when using them over a long period of screen time (Singh et al., 2021). Collectively, these results indicate that the positive effect of digital eye strain is probably small and can possibly be overshadowed by behavioral and environmental factors, including the length of time at the screen, distance of gaze, blink rate, lighting, and ergonomics (Rosenfield, 2011; Sheppard & Wolffsohn, 2018; Kaur et al., 2022; Mataftsi et al., 2023).

The same interpretation is extended to visual performance claims. It can be expected that some lens designs, particularly those that combine both spectral filtering and glare reduction, can provide increased comfort in some viewing conditions. The review found initial indications that polarized or filtering techniques could help in reducing subjective visual fatigue and, in certain situations, enhance contrast sensitivity or task-specific comfort (Mercatelli, 2023; Saleem et al., 2025). However, the current evidence base is limited and diffuse, and it cannot be used to make generalized claims regarding general visual performance enhancement in users or circumstances. The majority of available studies are comparatively small, have different measures of outcome, or test short-term effects instead of long-term real-life performance. Consequently, the existing body of research endorses the existence of preferential gain as opposed to an overall optic benefit.

Clinically, it cannot be stated that there is currently much evidence to support a robust or general advantage of blue light-blocking glasses on core visual functions like visual acuity. The literature that is available as discussed in this review leads to the view that any benefit of visual quality is more likely to be associated with subjective comfort, visual fatigue, or glare reduction or even with contrast related performance rather than with a measurable improvement in baseline acuity in itself. This is a significant difference, as digital eye strain is multifactorial, and it depends on ocular surface symptoms, spectral light exposure, as well as on the behavior of the blink, the accommodative demand, and screen ergonomics (Rosenfield, 2011; Sheppard & Wolffsohn, 2018; Kaur et al., 2022; Mataftsi et al., 2023). Even though there are studies indicating that blue light-blocking or filtering lenses reduce eye stress and may lead to an improvement in contrast sensitivity or display comfort, no randomized evidence indicates a statistically significant clinically significant difference between the effects of blue light-blocking or filtering versus conventional lenses on general screen-related eye strain (Lin et al., 2017; Singh et al., 2021; Saleem et al., 2025). This indicates that these blue light-blocking glasses can be regarded as a supplement to be used by some symptomatic users especially when they complain of glare-related discomfort or when they complain of prolonged screen fatigue but they do not constitute the primary therapy of impaired visual acuity or a multifunctional solution to digital eye strain.

Sleep and hormonal regulation have a higher clinical impact than those of the visual outcomes. Available evidence that has been analyzed suggests that blue light-blocking glasses might be plausibly useful when used in the evening to limit nighttime exposure to short-wavelength light before sleep, especially among individuals with insomnia, delayed sleep phases, or excessive nighttime screen time (Chang et al., 2015; Esaki et al., 2016; Ostrin et al., 2017; Shechter et al., 2018). The primary clinically significant impact here seems to be a slight enhancement of sleep initiation or quality as a result of maintenance of circadian signaling and not a radical alteration in the overall sleep architecture. Likewise, light-induced melatonin suppression attenuation is the most evidently supported hormonal effect that offers biological proof of the intervention but cannot be viewed as evidence of a broader endocrine or psychiatric benefit yet (Cajochen et al., 2011; Chellappa et al., 2011; Figueiro et al., 2011; Chang et al., 2015; Onodera et al., 2025). A clinical implication of this is that, blue light-blocking glasses might be best indicated as a supportive behavioral therapy of circadian protection at night, and not as an independent therapy of chronic sleep disorders or a neuroendocrine intervention of general applicability.

The neuroendocrine and neurophysiological findings are also interesting, as they provide an extension of the discussion beyond the complaint of sleep and visual comfort to quantifiable biological outcomes. The most obvious endocrine marker of this field is melatonin. The data presented in the current article show that melatonin suppression under light can be reduced by optical filtering, and this supports the argument that blue light blocking glasses can alter a real physiological pathway, rather than only subjective perception (Cajochen et al., 2011; Figueiro et al., 2011; Onodera et al., 2025). It is a critical observation, as it enhances the biological foundation of these interventions. Nevertheless, the melatonin-related findings are still too early to conclude about more general neuropsychiatric or cognitive benefits. Though the article refers to the concept of serotonin and mood-related processes, there is less evidence to prove that blue light blocking glasses induce long-term effects on emotional well-being or psychiatric extent (Lam et al., 2016). On the same note, the emerging EEG work indicates that light-filtering glasses have the potential to trigger neural arousal indicators like frontal beta activity, but these results are tentative and need to be verified in larger and more varied populations before concrete conclusions can be made (Boere & Krigolson, 2024).

The wider implication of this review is that the contemporary illuminated setting is historically, as well as biologically, atypical. The amount of artificial light to which humans are subjected at night by indoor lighting, smartphones, tablets, monitors, and LED-based systems has changed significantly compared to the nocturnal conditions of the ancestors (Chang et al., 2015; Gringras et al., 2015; Heo et al., 2017). Conversely, moonlight, firelight, starlight, and occasional bioluminescence sources were mostly the only sources of early nighttime light, all of which were much dimmer and of different colors than modern artificial sources (Martini & Haddock, 2017; Pogson, 1856). This comparison reinforces the concept that blue light rejection glasses are not merely accessories to consumers, but one solution that has been suggested as a measure to control a new environmental exposure. Nevertheless, the review also clarifies that these glasses cannot be viewed as a full-fledged solution. The behavioral interventions are also necessary, including decreasing screens prior to bedtime, decreasing evening lights, enhancing sleep hygiene, and setting up night settings on devices, which can become equally (or more) important than eyewear in some individuals (Gringras et al., 2015; Green et al., 2017; Heo et al., 2017).

There are also several limitations of the present evidence base which must be taken into account. First, the studies included are heterogeneous regarding the population, as some of them investigate healthy adults and others people with insomnia, delayed sleep phase disorder, or with certain visual complaints, which makes their generalization problematic (Esaki et al., 2016; Ostrin et al., 2017; Shechter et al., 2018). Second, the interventions differ significantly in terms of lens tint, spectral transmission, and short-wavelength attenuation, which is hard to compare directly. Third, most of the outcomes, particularly those obtained regarding digital eye strain and visual comfort, are subjective and thus prone to expectation or placebo effects. Fourth, most clinical trials measure relatively short-term effects, and it is therefore unclear on the long-term adherence, long-term effectiveness, and clinical relevance of clinical outcomes in the real world. Probably these are the reasons why the evidence seems to be stronger aimed at physiological plausibility than at large and substantial clinical effects.

Future studies should not focus on the general question of whether blue-light blocking glasses work or not, but rather clarify the conditions under which they are most effective. The field would benefit from more rigorous randomized controlled trials, using standardized lens specification, more detailed characterization of light exposure, and better delineation of sleep, circadian, visual, and neurocognitive outcomes. Comparative analysis of optical filtering and other interventions, including screen restriction, software night-modes, or environmental light-setting, would be useful too. Specifically, more objective measures like melatonin, actigraphy, validated digital eye strain scales, pupillary reactions, and electrophysiological indications would be useful to determine whether the purported benefits are the result of significant biological effects, self-preference, or both.

8. Conclusion

In summary, the evidence considered in this article suggests a balanced conclusion. Blue light blocking glasses seem to be a potentially effective intervention in minimizing evening circadian disruption and maintaining the melatonin signaling, especially in individuals with a significant amount of evening screen time or an inherent sleep vulnerability. Their contribution to digital eye strain and visual performance is less definitive, and mixed results indicate that any advantage is probably selective, not general. There are growing neuroendocrine and neurophysiological indications that are potential but still preliminary. Taken together, the idea of blue light-blocking glasses can be seen as a highly feasible addition to a broader approach to light management, rather than a complete solution to sleep or visual and cognitive well-being.

Conflict of Interest Statement

The authors declare no conflict of interest.

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