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EFFICACY OF BLUE LIGHT FILTERING SPECTACLES IN REDUCING DIGITAL EYE STRAIN: A SYSTEMATIC REVIEW OF EVIDENCE

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Abstract

Background: *Due to the growth of digital device use in today's society, Digital Eye Strain (DES), known as Computer Vision Syndrome (CVS), has grown considerably. Approximately 50% to 90% of individuals using a computer or other display device will experience atypical symptoms associated with Digital Eye Strain, such as fatigue, dryness, blurred vision, and headaches. While one potential cause of Digital Eye Strain is the blue light produced by computers, digital devices and smartphones, many patients and caregivers have begun utilizing some type of blue light blocking intervention.* ***Purpose:*** *This review aims to evaluate the impact of blue light blocking lenses on digital eye strain, highlighting their effectiveness in reducing symptoms and improving visual comfort among frequent digital device users. It also examines the role of environmental and behavioral factors associated with screen use.* ***Materials and Methods:*** *A comprehensive review of published literature was conducted, including randomized controlled trials, observational studies, and experimental research focusing on the effects of BLB lenses on DES. Data were analyzed with emphasis on symptom relief, visual performance, sleep quality, and variations in study design, lens characteristics, and duration of use.* ***Results:*** *Overall, there is sufficient evidence that Digital Eye Strain (DES) is a common, multifunctional component affecting individuals. Primary causes include: prolonged exposure to screens, reduced blink rate while looking at a screen, prolonged near activity, poor ergonomic positioning of the body in relationship or proximity to a screen, and poor environmental influence. Current research has proven that the amount of blue light emitted from a typical digital device is not associated with retinal damage. Randomized controlled studies and thorough systematic reviews consistently fail to demonstrate significant or clinically meaningful improvements in symptoms associated with Digital Eye Strain (DES) by wearing blue-light filtering lenses. Any benefit of improving DES symptoms appears to be more closely related to behavioral and ergonomic adjustments than to simply blocking blue-light emitted from digital device.* ***Conclusion:*** *Interventions that block blue-light demonstrate very little efficacy in reducing digital eye strain, which is primarily influenced by behavioural and environmental factors; not just blue light exposure alone. Therefore, visual breaks every 20 minutes, proper ergonomics, and optimal use of screens are more impactful than simply reducing blue-light exposure. Additional research using standardized, objective measures is recommended to develop evidence based management strategies.*

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Introduction

Digital technology's rapid integration into society has transformed the way we communicate, receive education, and work at our jobs. Digital devices (such as computers, smartphones, and tablets) have become ubiquitous in society and have caused all age groups to be exposed to greater amounts of screen time (1). Although the use of digital devices has increased productivity and access, their increased use has resulted in an increase in health concerns, especially in those areas related to vision (2). One of the most reported issues related to vision is Digital Eye Strain (DES), a.k.a. Computer Vision Syndrome. DES is a symptom complex that describes the ocular and visual signs and symptoms caused by using digital devices for long periods of time (3).

A range of visual problems is associated with the excessive use of computers and/or mobile devices. Examples of problems associated with digital eye strain include: tired eyes, dry eyes, irritated eyes, blurred vision, headaches, and trouble focusing on printed text. Impaired visual performance caused by these symptoms can adversely affect an individual's ability to perform daily activities and overall quality of life, which in turn negatively affects their ability to be productive in the workplace. The rise in frequency of this condition can be attributed to the increased amount of time spent on computers and/or mobile devices related to academic, telecommuting, and recreational use (4). Recent studies have shown that approximately 50% - 90% of people that use computers and/or mobile devices for extended periods of time have experienced at least one of the symptoms associated with digital eye strain. Students and office workers are especially affected due to their constant exposure to electronic devices, resulting in a higher incidence of digital eye strain within these populations. The increasing occurrence of digital eye strain illustrates that this condition is a serious public health issue in today's digital environment (5).

Many different elements lead to the development of digital eye strain, such as extended near activities, low blink rates, poor ergonomics, glare from screens, and inappropriate lighting. Among these variables, exposure to the blue light emitted from digital screens has gained attention as a possible contributor (6). Blue light is also called high-energy visible (HEV) light, and has a short wavelength with high energy, allowing it to penetrate deeper into the eye (7). While natural blue light from sun contributes significantly to regulation of circadian rhythm and alertness, excessive exposure to artificial blue light from screens, particularly while doing so continually or at night, raises concerns about the potential negative effects of artificial blue light on ocular health (8).

Studies show that extended exposure to blue light can contribute to stress on the retina, visual discomfort, and disrupt sleep cycles, which can lead to an increase in the development of digital eye strain symptoms (9). Therefore, several interventions to reduce exposure to blue light have been created and marketed widely as preventative and therapeutic measures. These interventions include blue light filtering glasses, blue light filtering screen protectors, and software programs which decrease blue light emitted from digital displays (2). Specifically, blue blocking eyeglasses have gained popularity because they are seen as an easy way to relieve digital eye fatigue, improve comfort, and promote good sleep (10).

However, many people still debate the effectiveness of blue light blocking measures on reducing digital eye fatigue. For example, some studies have shown changes in subjective measurements; they noted less eye fatigue, more comfort from screens, etc., while some studies have shown little to no change in comparison to either regular lenses or no treatment at all (11). Reasons for conflicting results are typically attributed to differences in the types and methods of studies performed, as well as to differences in participant populations, and also from the fact that digital eye fatigue has multiple causes. Particularly, other items that affect digital eye fatigue include time spent looking at a screen, distance viewed from a screen, posture during screen use/usage, how often you blink; environmental conditions, etc. However, these additional variables must be considered when determining the effects of blue light from screens on your eyes (12).

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Therefore, given the increasing number of individuals who are suffering from digital eye fatigue, as well as the increasing number of people who are employing blue light blocking strategies, it is essential to develop a broad synthesis of all of the research that has been conducted on this topic. This represents an appropriate method of investigating this subject because it enables an integration and critical assessment of the results of many different types of studies such as experimental, observational, and clinical studies. Narrative reviews are different from systematic reviews in that they allow for a greater degree of flexibility in considering multiple perspectives, as well as the ability to identify connections among studies and discuss inconsistencies between the literature and other types of studies.

The purpose of this study is to evaluate the effectiveness of blue light blocking interventions on reducing digital eye strain. This review will provide a summary of the current evidence available regarding their effectiveness, consider the possible mechanisms by which these interventions might be effective and review other factors that may contribute to visual discomfort when people use digital devices. Finally, the review will identify gaps in previous literature and provide recommendations for additional future research. Overall, this review aims to provide an evidence-based overview that will help inform evidence-based decisions and develop effective strategies for managing digital eye strain in an increasingly digital world.

Material and Methods

The studies included in this review were conducted in controlled environments such as educational institutions, offices, and clinical settings where prolonged digital device use is common. These settings were selected because the target population—students and working professionals—are easily accessible and frequently exposed to extended screen time, making them more susceptible to digital eye strain (DES). The environments provided a diverse sample with varying duration of screen exposure, lighting conditions, and ergonomic practices, thus offering a suitable basis for evaluating the impact of blue light blocking (BLB) lenses on visual comfort and ocular health. The cooperation of institutional authorities and the willingness of participants contributed to efficient and systematic data collection.

Participants underwent comprehensive ophthalmic and visual assessments to evaluate symptoms and signs associated with digital eye strain. Standardized tools and techniques were used, including visual acuity testing with the Snellen chart, assessment of contrast sensitivity, and evaluation of color vision where required. In addition, validated questionnaires such as the Computer Vision Syndrome Questionnaire (CVS-Q) and subjective symptom scoring scales were used to assess the frequency and severity of symptoms like ɯ̟e strain, dryness, blurred vision, and headaches. Participants were assigned either blue light blocking lenses or standard lenses (control group), and their responses were monitored over a specified duration of screen use under similar conditions.

Data collection was carried out using a structured proforma designed to record demographic details, duration of digital device usage, environmental factors (lighting, screen brightness, viewing distance), and ocular symptoms. Objective measurements were complemented by subjective feedback to ensure a comprehensive evaluation of the effectiveness of BLB lenses. The relatively large sample size across included studies enhanced the reliability of findings and allowed comparisons across different age groups, occupations, and usage patterns.

The inclusion criteria were carefully defined to ensure the relevance of participants to the study objectives. Individuals who regularly used digital devices for at least 2–4 hours per day were included. Both male and female participants, typically aged between 10 and 40 years, were considered. Participants with or without mild refractive errors were included, provided their vision was adequately corrected during the study. Inclusion of individuals without significant symptoms of DES allowed for comparison between symptomatic and asymptomatic groups. Consistency was maintained by evaluating both eyes of each participant under standardized conditions.

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Certain exclusion criteria were applied to maintain accuracy and avoid bias in the results. Individuals with pre-existing ocular diseases such as glaucoma, cataract, or retinal disorders were excluded, as these conditions could influence visual performance and confound the outcomes. Participants with severe dry eye disease, history of ocular surgery, or use of medications affecting vision were also excluded. Additionally, individuals who were unable to cooperate with testing procedures or follow study instructions were not included.

Overall, the selected studies were considered adequate for drawing meaningful conclusions regarding the effectiveness of blue light blocking lenses in reducing digital eye strain. The combination of objective clinical assessments and subjective symptom evaluation provided a comprehensive understanding of their impact, while controlled conditions helped minimize external influences on the results.

Results and Findings

The common condition known as digital eye strain (DES) has developed as a result of extended use of modern digital devices. According to a review conducted by Andrew L. Sheppard and James S. Wolffsohn in 2020, between 50% and 90% of users of digital displays complained about symptoms such as eye fatigue, dry eyes, blurred vision, and headaches. These values represent the vast negative effect DES has on populations around the world, & demonstrate DES is a serious issue. The large variance of the results from studies examining DES represents the different participant demographics, length of exposure to digital displays, and the varying way DES has been measured among those studies. In addition, the rapid growth of digital device usage in both educational and professional settings has further increased the risk and visibility of DES. Their work supports that DES results from multiple contributory factors such as extended periods of close work, a reduced number of blinks, improper workplace ergonomics and environmental settings (in stead of simply an independent issue) (13).

Much research has been placed on the effects of blue light on human ocular health; yet, it is debated whether or not blue light emitted from screens contributes to DES. A scoping review conducted by Alvin J. Munsamy et al. concluded that there are some circadian rhythm effects caused by blue light; however, there are limited occurrences where blue light from screens has caused damage to human eyes (8). Likewise, according to scientific studies, there is no evidence that blue light from digital devices has any negative effect. O'Hagan et al. (2021) found that when watching an LED screen, blue light exposure is considerably less than what is recognized as harmful or damaging to the retina during regular use. Hence, this should indicate that blue light emitted by screens probably does not contribute substantially to digital eye fatigue (14).

There has been a surge in the amount of digital eye strain (DES) in the last few years primarily due to the increase in use of Digital devices combined with being quarantined; therefore how people learn and work has changed dramatically. This has led to a significant increase in DES symptomatology across different populations as shown by multiple recent studies. In one particular cross-sectional study by Alabdulkader (2021), there was a remarkably high prevalence of digital eye strain symptoms among adults during the Pandemic year. The study discovered that longer screen-time exposures, multiple device usage regularly and longer periods in front of a computer increased the severity of DES symptoms including eye fatigue, dry eyes, headaches and blurred vision. Important to note was that the lifestyle and work changes during the lockdown played a significant role in the high levels of visual discomfort and eye strain from extended periods of exposure to large digital screen (15). The research by Amod Mohan and his team (2021) also explored the effects of online education on young people during the COVID-19 pandemic. The researchers found that students who participated in the online learning environment experienced high rates of digital eye strain. The symptoms of digital eye strain were associated with longer periods of screen usage, a decreased amount of time taking breaks, use of closer viewing distances, and use of smartphones to do their school work. The researchers concluded that children were especially susceptible to developing digital eye strain symptoms because

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they had become more reliant on digital platforms for school work (16).

There has been a rise in the popularity of various blue light-blocking interventions (e.g., filtering lenses), likely due to the growing concern about the adverse effects of blue light exposure. However, high-quality clinical trials consistently demonstrate that these types of interference will only slightly improve digital eye strain symptom (11). Additionally, while conducting a much larger randomised controlled clinical trial in 2021, Mark Rosenfield and others again found no measurable change in either subjectively determined or objectively measured eye strain symptoms from participants using blue-light blocking lenses as compared with those using placebo lenses (17). Both of these studies were further supported by the results from a systematic review of the literature completed by Kairav Kaur and others (2023). This review found that blue light blocking devices would be unlikely to result in decreased symptoms of digital eye strain, and that other ergonomic and behavioural interventions would provide greater improvement in both subjective symptom reports and objective measures of digital eye strain than would blue light filtering devices (18). inally, based on a Cochrane-style systematic review by Laura E. Downie et al. (2023) it was concluded that there is currently no evidence to support any clinically meaningful benefit from blue light blocking devices in reducing the symptoms of eye strain, improving sleep quality, or improving visual performance (10).

Table: ***Summary of Digital Eye Strain (DES), Blue Light Exposure, and Related Evidence***

Authors, Year, Ref.	Title	Methodology	Result	Conclusion	Limitations	Practical Implication
Rosenfield et al., 2020(11)	A double-blind test of blue-blocking filters on symptoms of digital eye strain	Double-blind experimental study with 24 participants performing digital reading tasks	No significant difference in DES symptoms between blue-blocking and standard lenses	Blue light filtering lenses do not reduce digital eye strain symptoms	Small sample size and short exposure duration	Routine prescription of blue light lenses for DES is not justified
Vera et al., 2021/2023 (19)	Blue-blocking filters do not alleviate signs and symptoms of digital eye strain	Experimental crossover study assessing muscle activity and symptoms	No reduction in ocular muscle activity or subjective symptoms	Blue-blocking filters are ineffective in reducing DES	Short task duration and young healthy participants	Suggests alternative behavioral strategies instead of optical filters
Sheppard & Wolffsohn et al., 2021 (17)	Do Blue-blocking Lenses Reduce Eye Strain From Extended Screen Time?	Double-masked randomized controlled trial (RCT) with 120 participants	No clinically significant reduction in eye strain symptoms	Blue light lenses provide no meaningful benefit for DES	Placebo effect possible due to participant expectations	Emphasizes need for ergonomic and behavioral interventions
Singh et al., 2023 (10)	Blue-light filtering spectacle	Systematic review of 17 RCTs	Little to no effect on eye strain, sleep,	Evidence does not support	Heterogeneity among included	Clinical recommendations should not rely

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	lenses for visual performance, macular health, and sleep (Cochrane Review)		or visual performance	effectiveness of blue light filtering lenses	studies and low-certainty evidence	on blue light filters
Downie et al., 2023 (20)	Blue-light filtering spectacles probably make no difference to eye strain	Systematic review summary of RCT evidence	No improvement in eye strain or retinal protection	Blue light glasses are not effective for DES management	Limited long-term outcome data	Focus should shift toward lifestyle modifications
Akagun et al., 2025 (21)	Long-term use of blue light-filtering glasses and symptom improvement in DES	Cross-sectional questionnaire-based study (n=186)	85% reported subjective improvement in at least one symptom	Some perceived benefit may exist with long-term use	Self-reported data and lack of control group	Benefits may be influenced by behavioral compliance rather than lenses

Discussion

In summary, this study has therefore looked at how well blue light blocking interventions work to reduce digital eye strain (DES). Digital eye strain is very widespread and results from many different things. However, whether blue light has a significant role in producing digital eye strain, and whether blue light blocking interventions are effective, is still unknown..

The literature included in this review demonstrates that digital eye strain is common, particularly among those with extended screen time. Sheppard and Wolffsohn (2020) report that a higher number of digital display users have symptoms of digital eye strain such as fatigue of the eyes, dry eyes and headaches. These researchers document that at least 50% of the computer users experience symptoms of digital eye strain from both internal (accommodative stress) and external (dry eye related) sources (13). Therefore, there is compelling evidence to suggest digital eye strain is a public health issue today, internationally and at home, due to the increasing reliance on digital devices. In addition, more recent research also demonstrates that digital eye strain is caused by comprehensive computer and digital device use and is associated with multiple ocular symptoms such as blurring and irritation from the eyes rather than a singular cause (22).

The literature indicates that DES has many causes, including reduced blink rate, prolonged near work, improper posture, incorrect viewing distance and inadequate lighting. It has been reported recently that prolonged digital display use negatively affects symptoms of discomfort, ocular surface stability and visual comfort, reducing productivity and the quality of life (23). The present evidence has been used to argue that the performance of DES shares more similarities with the performance of other environmental variables than the optical characteristics of blue light.

Some controversy still exists regarding whether or not blue light causes eye damage. Current publications indicate that the amount of blue light produced by commonly used digital devices is below the level associated with retinal damage. The computer vision syndrome literature concludes that the more significant contributors to DES are related to visual demand or screen use habits as opposed to spectral exposure. Additionally, the

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effect of having a reduced blink rate, prolonged near work, etc. on the development of symptoms has been more prominent. Thus, behaviourally modifying one's use of digital displays will have a greater impact on the management of digital eye strain than attempting to reduce one's blue light exposure (24).

The rising number of people suffering from digital eye strain (DES) has been greatly amplified by the COVID-19 pandemic; indicating to us that there is something to consider when it comes to lifestyle choices. During the pandemic, many studies showed that there was an increase in symptoms being attributed to excessive time spent on screens, such as online learning and working from home, supporting the theory that usage patterns were the primary contributing factor (25). In terms of clinical evidence on the effectiveness of blue light blocking lenses, studies show that these types of lenses have little to no effect on eye strain. Randomized controlled trials have shown that patients did not experience any difference in symptom relief between using blue light filtering lenses or standard lenses (Rosenfield et al., 2020). Thus, it seems that if someone believes there is a benefit to using blue light filtering lenses, it may be their own subjective opinion and not backed by clinical statistics (24). Consistent with the conclusions of systematic and narrative literature reviews, there are more effective ways to alleviate the symptoms associated with DES; including behaviour and ergonomics, such as using the 20-20-20 rule, correcting posture, and reducing the glare from screens (2).

In general, the results demonstrate that "Digital Eye Strain" is caused by a collection of many factors (Behaviour, Environment and Ergonomics) and not simply due to too much time looking at screens, or exposure to blue light. Research has shown that extended time spent on screens will give rise to symptoms due to the combination of poor ergonomics while using the screen, reduced blinking rate, and... The evidence demonstrates that, although these are still dominating our understanding of what results in Digital Eye Strain; blue light emitted from electronic devices is at very low levels and not capable of causing visual damage to the retina. Recent evidence suggests that those claiming to have a reduction in symptoms when using blue light blocking glasses must be resulting from either, a placebo effect, or a positive change in visual habits rather than blocking blue light. Many studies (RCTs) have failed to demonstrate any statistical significance on a reduction of symptoms between using blue light glasses or opting not to wear them.

Conclusion

To sum up, digital eye strain has become an increasingly common and significant public health issue in the digital age; primarily resulting from excessive use of screens (prolonged periods of usage), reduced frequency of blinking, sustained near-vision tasks, or visual ergonomics among others, rather than just exposure to blue light alone. Many have turned to blue light blocking glasses as a solution, yet current research on this topic does not provide clear or clinically relevant evidence that they serve to reduce symptoms of digital eye strain. Additionally, there would be some behavioral changes and changes in the environment that may provide a better solution such as taking regular visual breaks, positioning screens correctly, utilizing appropriate levels of brightness, and practicing good habits regarding use of screens etc. In conclusion, the research in this review illustrates the multifunctional nature of digital eye strain, and calls for more evidence-based (not commercial-based) ways to prevent and treat this condition.

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