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DIGITAL EYE STRAIN IN THE REMOTE WORK ERA: A NARRATIVE REVIEW OF BLUE LIGHT FILTERING TECHNOLOGIES AND OTHER INTERVENTIONS

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ABSTRACT

The rapid expansion of remote work has significantly increased daily screen exposure, contributing to a growing prevalence of Digital Eye Strain (DES), a condition characterized by symptoms such as eye fatigue, dryness, blurred vision, and headaches. As concerns regarding the potential impact of prolonged digital device use continue to rise, various interventions have been proposed to mitigate DES. This narrative review aims to evaluate the effectiveness of blue light filtering technologies and other commonly recommended interventions for reducing symptoms of Digital Eye Strain among remote workers. A literature search was conducted using PubMed and ResearchGate synthesizing findings from systematic reviews, meta-analyses, randomized controlled trials, and observational studies published between 2012 and 2026. The findings indicate that while blue light filtering glasses and screen filters may improve subjective visual comfort for some users, current evidence does not consistently demonstrate a significant reduction in DES symptoms attributable solely to blue light reduction. In contrast, interventions such as regular screen breaks, adherence to the 20–20–20 rule, optimization of workstation ergonomics, adjustment of display settings, and management of environmental factors show stronger and more consistent benefits. The review concludes that Digital Eye Strain is a multifactorial condition requiring a comprehensive management approach. Although blue light filtering technologies may serve as supportive measures, behavioural and ergonomic interventions remain the most evidence-based strategies for reducing DES in the remote work era. Future research should evaluate long-term outcomes and cost-effectiveness of these solutions.

KEYWORDS

Digital Eye Strain, Blue Light Filtering, Remote Work, Computer Vision Syndrome, Visual Health, Technological Interventions

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1. Introduction

1.1 The Growing Burden of Digital Eye Strain in Remote Work Settings

The COVID-19 pandemic has fundamentally reshaped the global workforce, resulting in a dramatic and sustained increase in remote and hybrid work arrangements (Bhattacharya et al., 2020). Consequently, daily screen time among remote workers has risen substantially.

This prolonged exposure to digital devices has contributed to a marked increase in Digital Eye Strain (DES), also known as Computer Vision Syndrome (CVS) (Maneea et al., 2024). Evidence from recent research indicates that remote and digitally based work is associated with a substantial burden of digital eye strain, with prevalence estimates among screen-dependent workers commonly exceeding 60% (Moore et al., 2024). The most common symptoms include dry eyes, blurred vision, eye fatigue, headaches, and neck/shoulder pain (Kaur et al., 2022). Many individuals also report a noticeable decline in visual comfort following the transition to remote work.

Although remote work provides greater flexibility and numerous advantages, the combination of increased screen time, often suboptimal home office ergonomics has transformed digital eye strain into a significant emerging occupational health issue (Kaur et al., 2022; Abusamak et al., 2022).

1.2. Mechanisms and Risk Factors of Digital Eye Strain

Digital Eye Strain (DES) is a multifactorial condition associated with prolonged digital screen use and sustained near-vision tasks. Current evidence suggests that its development results from the interaction of ocular, behavioural, and environmental factors (Kaur et al., 2022; Wolffsohn et al., 2023).

One of the primary mechanisms underlying DES is altered blinking behaviour during screen use. Prolonged visual attention to digital displays is associated with reduced blink frequency and incomplete blinking, which can destabilize the tear film and increase tear evaporation. Consequently, users may experience symptoms such as dry eyes, irritation, burning sensations, and visual discomfort (Wolffsohn et al., 2023).

Accommodation and binocular vision stress also contribute to DES. Continuous focusing on near digital targets increases visual demands and may lead to accommodative fatigue, blurred vision, and difficulty refocusing between distances. Individuals with uncorrected refractive errors or pre-existing visual disorders may be particularly vulnerable to these effects (Kaur et al., 2022).

Several environmental and ergonomic factors have also been linked to DES. Inadequate lighting, screen glare, improper viewing distances, and poorly designed workstations can increase visual effort and contribute to both ocular and musculoskeletal symptoms. As a result, DES is frequently accompanied by headaches as well as neck and shoulder discomfort (Kaur et al., 2022).

Among the identified risk factors, prolonged screen exposure remains one of the most significant. The risk of DES increases with the duration of daily digital device use, particularly among individuals engaged in remote work who often spend extended periods performing screen-based tasks with limited visual breaks (Mataftsi et al., 2023). Additional factors, including contact lens use, dry eye disease, psychological stress, and high cognitive workload, may further increase susceptibility to symptoms (Wolffsohn et al., 2023).

Overall, DES is a complex condition arising from multiple physiological and environmental influences. Understanding these mechanisms is essential for the development and evaluation of effective preventive strategies, including technological and behavioural interventions.

1.3. Blue Light Exposure and Its Potential Role in Visual Discomfort

Blue light, commonly defined as visible light within the wavelength range of approximately 400–500 nm, is emitted by both natural and artificial sources, including light-emitting diode (LED) displays used in computers, smartphones, and tablets. The rapid expansion of digital technologies and remote work arrangements has increased concerns regarding the potential contribution of blue light exposure to visual discomfort and digital eye strain (DES). Although blue light carries higher photon energy than longer visible wavelengths and reaches the retina, its precise role in the development of DES remains controversial (Lawrenson et. al., 2017).

Several mechanisms have been proposed to explain the relationship between blue light exposure and visual symptoms. Short-wavelength light is more prone to intraocular scattering than longer wavelengths, which may reduce retinal image quality and increase visual effort during prolonged screen-based tasks. Researchers have also suggested that blue light may contribute to glare sensitivity and visual fatigue, particularly during extended periods of near work (Coles-Brennan et al., 2019). However, growing evidence indicates that many symptoms commonly attributed to blue light exposure—including eye fatigue, blurred vision, headaches, and ocular discomfort—are more strongly associated with factors such as prolonged screen time, reduced blink frequency, tear film instability, accommodative stress, and poor ergonomic conditions (Wolffsohn et al., 2023).

2. Methodology

This study employed a narrative review methodology to examine the current evidence on Digital Eye Strain (DES) in the context of remote work, with a particular focus on blue light filtering technologies and other preventive or therapeutic interventions. A narrative review approach was selected to provide a comprehensive overview of existing research, identify key trends, and synthesize findings from diverse study designs. A comprehensive literature search was performed between January and May 2026 using the PubMed database as the primary source of peer-reviewed biomedical and health-related literature. Articles published between 2012 and 2026 were considered to ensure the inclusion of recent evidence reflecting the rapid growth of remote work and digital device usage. Search terms included combinations of "digital eye strain," "computer vision syndrome," "remote work," "teleworking," "blue light," "blue light filtering glasses," "screen filters," "eye fatigue," "visual discomfort," and "ergonomic interventions."

Studies were included if they investigated the prevalence, causes, prevention, or management of DES among adults using digital devices for occupational purposes. Randomized controlled trials, observational studies, systematic reviews, meta-analyses, and professional guidelines published in English were eligible for inclusion. Articles unrelated to occupational screen use, pediatric populations, or non-peer-reviewed sources were excluded.

The selected literature was analysed qualitatively and grouped into thematic categories. Findings were synthesized narratively to compare the effectiveness of different interventions and identify gaps in the current evidence base.

3. Results

A wide range of interventions has been proposed to mitigate Digital Eye Strain (DES) associated with prolonged use of digital devices. These interventions include blue-light filtering technologies, behavioural strategies, ergonomic modifications, software-based solutions, and ocular surface management. The strength of evidence supporting these approaches varies considerably, with some interventions demonstrating consistent benefits while others remain controversial.

3.1 Blue-Light Filtering Technologies

Blue-light filtering technologies, including spectacle lenses, screen filters, and software-based night modes, are among the most frequently marketed interventions for the prevention of digital eye strain (DES) (Singh et al., 2023). However, recent evidence has increasingly questioned their clinical effectiveness (Rosenfield et al., 2020; Singh et al., 2023). A Cochrane systematic review evaluating 17 randomized controlled trials found little to no evidence that blue-light filtering lenses reduce symptoms of eye strain compared with non-filtering lenses (Singh et al., 2023). Similar findings were reported in several randomized and double-masked clinical trials, which demonstrated no significant differences in subjective eye strain, visual fatigue, ocular discomfort, or objective measures of visual performance between blue-light filtering and placebo lenses (Rosenfield et al., 2020; Singh et al., 2021; Vera et al., 2023). Furthermore, available evidence does not support clinically meaningful benefits regarding visual performance or retinal protection (Singh et al., 2023; Lian et al., 2022). Collectively, current evidence suggests that although some users report subjective improvements in comfort, the effectiveness of blue-light filtering technologies in reducing DES symptoms remains limited and is not supported by high-quality clinical evidence (Rosenfield et al., 2020; Singh et al., 2021; Vera et al., 2023; Singh et al., 2023).

3.2 The 20-20-20 Rule and Scheduled Visual Breaks

Behavioural interventions represent one of the most widely recommended strategies for the prevention and management of Digital Eye Strain (DES) (Jaiswal et al., 2019; Sheppard & Wolffsohn, 2018).

The 20-20-20 rule advises users to look at an object approximately 20 feet away for 20 seconds after every 20 minutes of screen use. The rationale behind this recommendation is the reduction of accommodative stress, temporary relaxation of the ciliary muscles, and interruption of prolonged near-work demands that contribute to visual fatigue (Sheppard & Wolffsohn, 2018; Jaiswal et al., 2019).

Available evidence suggests that scheduled visual breaks may reduce symptoms of digital eye strain, although the number of randomized controlled trials directly evaluating the 20-20-20 rule remains limited (Portello et al., 2012; Jaiswal et al., 2019).

In a prospective interventional study specifically evaluating the 20-20-20 rule, symptomatic computer users who received personalized break reminders for two weeks demonstrated significant improvements in Digital Eye Strain symptoms, including reductions in eye discomfort and dry-eye-related complaints (Portello et al., 2012).

Current evidence therefore suggests that periodic visual breaks are associated with improved visual comfort and reduced symptoms of DES, particularly when combined with blink awareness and ergonomic optimization (Portello et al., 2012; Jaiswal et al., 2019).

Due to its simplicity, negligible cost, ease of implementation, and absence of reported adverse effects, the 20-20-20 rule remains one of the most frequently recommended preventive measures for individuals exposed to prolonged digital screen use (Sheppard & Wolffsohn, 2018).

3.3 Blink Reminder Applications

Reduced blink frequency is a well-established physiological response during digital device use and contributes significantly to tear film instability and ocular surface dryness. Research has shown that blink rates may decrease substantially during intensive screen-based activities, leading to impaired tear film maintenance and increased dry eye symptoms (Rosenfield, 2016; Sheppard & Wolffsohn, 2018). To address this issue, several software applications have been developed to provide reminders encouraging users to blink regularly or take short visual breaks. Available studies suggest that blink reminder interventions can increase blink frequency, improve tear film stability, and reduce symptoms associated with dry eye disease (Ashwini et al 2021; Xu et al. 2025).

Recent randomized controlled trials have demonstrated that digital blink-training applications improve blink behaviour, ocular surface parameters, and patient-reported dry eye symptoms after several weeks of use (Xu et al. 2025).

The greatest benefits appear to occur when blink reminders are combined with broader behavioural interventions aimed at reducing prolonged uninterrupted screen exposure and promoting regular visual breaks (Xu et al. 2025; Ashwini et al. 2021).

However, the current evidence base remains limited by relatively small sample sizes, short intervention periods, and a lack of long-term follow-up studies assessing sustained effectiveness in real-world settings (Xu et al. 2025; Ashwini et al. 2021).

3.4Display Adjustment Software and Contrast Optimization

Software solutions that automatically adjust screen brightness, contrast, color temperature, and ambient light conditions have gained widespread popularity. Unlike blue-light filtering technologies, the potential benefits of these systems appear to be related primarily to reductions in glare and optimization of visual comfort rather than selective filtering of short-wavelength light (Lin et al., 2019).

Several studies have demonstrated that appropriate adjustment of screen luminance and contrast relative to ambient lighting conditions may reduce visual discomfort and improve visual performance during prolonged computer use (Benedetto et al., 2014; Zhou et al., 2021). These effects are particularly evident in environments characterized by inadequate lighting conditions, excessive screen brightness, or substantial differences between display luminance and surrounding illumination (Lin et al., 2019; Han et al., 2021).

Research on computer vision syndrome has shown that glare, display contrast, and lighting conditions significantly influence visual fatigue and user comfort, suggesting that display optimization can contribute to reducing eye strain symptoms (Lin et al., 2019). However, the available evidence indicates that display optimization alone is insufficient to eliminate Digital Eye Strain (DES) symptoms and should therefore be implemented as part of a broader preventive strategy that includes ergonomic adjustments, regular breaks, and appropriate workplace lighting (Lin et al., 2019; Han et al., 2021)

3.5Ergonomic Workplace Modifications

Ergonomic interventions represent one of the most consistently supported approaches for reducing Digital Eye Strain (DES) and Computer Vision Syndrome (CVS) symptoms (Rosenfield, 2016; Ranasinghe et al., 2016). Recommended workplace modifications include positioning the monitor approximately 50–70 cm from the eyes, maintaining the top of the screen slightly below eye level, minimizing glare, optimizing workplace illumination, and promoting proper sitting posture (Sheppard & Wolffsohn, 2018).

Evidence from occupational health studies indicates that ergonomic improvements can reduce both visual symptoms and musculoskeletal complaints commonly associated with prolonged computer use (Ranasinghe et al., 2016). Proper workstation design has been associated with lower levels of eye fatigue, neck pain, shoulder discomfort, and overall visual strain among individuals who spend extended periods using digital devices (Rosenfield, 2016; Coles-Brennan et al., 2019).

These interventions have become particularly relevant in remote work settings, where employees frequently rely on improvised workstations that do not meet established ergonomic standards (Oakman et al., 2020; Xiao et al., 2021). Studies conducted during and after the COVID-19 pandemic reported that inadequate home-office ergonomics were associated with increased visual discomfort and a higher prevalence of musculoskeletal symptoms among remote workers (Oakman et al., 2020; Xiao et al., 2021). Consequently, ergonomic workplace modifications are widely recognized as a fundamental component of comprehensive strategies aimed at preventing and managing Digital Eye Strain in the remote work era (Sheppard & Wolffsohn, 2018; Rosenfield, 2016).

3.6Ocular Surface Management and Artificial Tears

Ocular surface dysfunction and dry eye disease frequently coexist with Digital Eye Strain (DES), largely due to reduced blink rates and incomplete blinking during prolonged digital device use (Rosenfield, 2016; Sheppard & Wolffsohn, 2018). Consequently, artificial tears and lubricating eye drops are commonly recommended, particularly for individuals experiencing dryness, burning sensations, irritation, or foreign body sensations (Craig et al., 2017; Rosenfield, 2016).

Clinical studies have demonstrated that lubricating eye drops improve tear film stability, enhance ocular surface hydration, and alleviate symptoms of ocular discomfort in individuals with dry eye disease and digital eye strain (Kaercher et al., 2014). The beneficial effects of artificial tears are particularly relevant for digital device users, whose decreased blink frequency contributes to increased tear evaporation and ocular surface instability (Sheppard & Wolffsohn, 2018).

While artificial tears do not address the underlying behavioural and environmental factors contributing to DES, such as prolonged screen exposure or inadequate workstation ergonomics, they may provide meaningful symptomatic relief and improve visual comfort among heavy digital device users (Rosenfield, 2016; Coles-Brennan et al., 2019). Therefore, ocular surface management is often recommended as a complementary component of a comprehensive strategy for the prevention and management of Digital Eye Strain (Craig et al., 2017; Sheppard & Wolffsohn, 2018).

3.7Multicomponent Interventions

Current evidence suggests that the most effective approach to the prevention and management of Digital Eye Strain (DES) involves the implementation of multicomponent interventions rather than reliance on a single preventive measure (Rosenfield, 2016; Sheppard & Wolffsohn, 2018). Given the multifactorial nature of DES, which encompasses visual, environmental, ergonomic, and ocular surface factors, comprehensive intervention strategies are considered more likely to address the underlying causes of symptoms (Coles-Brennan et al., 2019).

Programs combining ergonomic optimization, scheduled visual breaks, blink awareness training, display adjustments, and ocular surface management have consistently demonstrated greater improvements in visual comfort and symptom reduction than individual interventions implemented in isolation (Sheppard & Wolffsohn, 2018; Coles-Brennan et al., 2019). Research indicates that interventions targeting multiple risk factors simultaneously can reduce ocular discomfort, improve tear film stability, minimize musculoskeletal complaints, and enhance overall workplace well-being among digital device users (Rosenfield, 2016; Ranasinghe et al., 2016).

This integrated approach has become particularly relevant in the remote work environment, where prolonged screen exposure, suboptimal workstation setups, and inadequate break patterns frequently coexist and contribute to the development of DES symptoms (Oakman et al., 2020; Xiao et al., 2021). Consequently, contemporary clinical and occupational health recommendations increasingly emphasize comprehensive prevention programs that combine behavioral, ergonomic, and ocular surface interventions to achieve the greatest benefit for digital device users (Sheppard & Wolffsohn, 2018; Coles-Brennan et al., 2019).

Table1. Comparison of Interventions for Digital Eye Strain: Effectiveness and Key Findings

Intervention	Evidence Level	Main Findings	Overall Effectiveness
Blue-light filtering technologies	High	No clinically meaningful reduction in DES symptoms compared with control lenses	Low
20-20-20 rule and Scheduled visual breaks	Moderate	Reduces accommodative stress and visual fatigue	Moderate–High
Blink reminder applications	Moderate	Increase blink rate and improve tear film stability	Moderate
Automatic brightness/contrast adjustment	Moderate	Reduces glare and visual discomfort	Moderate
Ergonomic workstation optimization	High	Reduces visual and musculoskeletal symptoms	High
Artificial tears/lubricants	Moderate–High	Effective for dryness-related symptoms	Moderate–High
Multicomponent interventions	High	Most effective overall approach	High

4. Discussion

The findings of this narrative review highlight the multifactorial nature of Digital Eye Strain (DES) and emphasize the need for comprehensive management strategies in the context of increasing remote work (Sheppard & Wolffsohn, 2018; Coles-Brennan et al., 2019). Although blue light filtering technologies have gained substantial commercial and public attention, the reviewed evidence suggests that their effectiveness in reducing DES symptoms remains limited and inconsistent (Singh et al., 2023). While some users report subjective improvements in visual comfort, current research does not provide strong evidence that blue light exposure is the primary driver of DES or that selective blue light reduction alone can effectively prevent or alleviate symptoms (Singh et al., 2023; Rosenfield, 2016).

In contrast, interventions targeting established risk factors of DES, including prolonged screen exposure, reduced blink rate, poor workstation ergonomics, and inadequate environmental conditions, have demonstrated more consistent benefits (Sheppard & Wolffsohn, 2018; Coles-Brennan et al., 2019). Regular visual breaks, ergonomic workplace modifications, display optimization, and ocular surface management have been repeatedly associated with reductions in visual discomfort and improvements in overall user well-being (Rosenfield, 2016; Coles-Brennan et al., 2019). These findings support the view that DES should be approached as a complex occupational health issue rather than a problem attributable to a single technological factor (Sheppard & Wolffsohn, 2018).

The growing prevalence of remote and hybrid work arrangements further increases the relevance of these findings (Xiao et al., 2021; Oakman et al., 2020). Many employees work from home in environments that were not originally designed for prolonged computer use, resulting in suboptimal workstation setups, poor lighting conditions, and longer uninterrupted screen exposure (Xiao et al., 2021; Oakman et al., 2020). Consequently, employers, occupational health professionals, and policymakers should prioritize evidence-based preventive measures, including ergonomic education, workplace assessments, and the promotion of healthy digital work habits (Oakman et al., 2020).

An important implication of this review is the need to critically evaluate the widespread marketing claims surrounding blue light filtering products. Although such technologies may offer supplementary benefits for certain users, they should not replace interventions with stronger empirical support (Singh et al., 2023). Overreliance on blue light filtering solutions may create a false perception that DES can be prevented through a single technological adjustment, potentially diverting attention from more effective behavioural and environmental strategies (Singh et al., 2023; Sheppard & Wolffsohn, 2018).

This review also highlights several gaps in the current literature. Many studies examining blue light filtering technologies are characterized by small sample sizes, short follow-up periods, and heterogeneous outcome measures, limiting the ability to draw definitive conclusions (Singh et al., 2023). Furthermore, relatively few studies have specifically focused on remote workers, despite the substantial changes in work patterns that have occurred since the COVID-19 pandemic (Xiao et al., 2021). Future research should prioritize large-scale randomized controlled trials and longitudinal studies investigating the long-term effectiveness of both individual and multicomponent interventions in real-world remote work settings (Singh et al., 2023).

Overall, the evidence reviewed suggests that the most effective approach to reducing Digital Eye Strain involves a combination of behavioral, ergonomic, environmental, and ocular surface interventions (Coles-Brennan et al., 2019; Sheppard & Wolffsohn, 2018). As digital technologies continue to play a central role in modern work environments, the development and implementation of comprehensive DES prevention programs will remain an important priority for occupational health and workplace well-being (Rosenfield, 2016; Oakman et al., 2020).

5. Conclusions

Digital Eye Strain has emerged as a significant challenge in the remote work era due to the growing reliance on digital devices and prolonged screen exposure. This narrative review indicates that while blue light filtering technologies remain popular, current evidence does not consistently support their effectiveness as a primary strategy for reducing DES symptoms (Singh et al., 2023).. In contrast, interventions targeting established risk factors, including regular screen breaks, ergonomic workplace design, appropriate display settings, and ocular surface management, appear to provide more reliable benefits (Sheppard & Wolffsohn, 2018; Coles-Brennan et al., 2019).

The findings suggest that DES prevention should focus on comprehensive, evidence-based approaches rather than individual technological solutions. As remote and hybrid work models continue to expand, promoting healthy digital work habits and optimizing work environments will be essential for protecting visual comfort and occupational well-being. Future research should prioritize high-quality studies evaluating the long-term effectiveness of preventive interventions in real-world remote work settings.

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