REVIEW PAPER

JMS Journal of Medical Science

The Impact of Digital Screens on Eye and Nervous System Health

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https://doi.org/10.20883/medical.e1283

Keywords: eye health, mental health, screen addiction, preventive strategies, screen time management

Received 2025-05-09
Accepted 2025-08-14
Published 2025-09-19

How to Cite: Gajewski Witold, Górski J, Janecka J, Hofman M, Skoczek W, Gałęcki W. The Impact of Digital Screens on Eye and Nervous System Health. Journal of Medical Science. 2025 September;94(3);e. doi:10.20883/medical.e1283

ABSTRACT

Introduction. The increasing reliance on digital technology has led to a significant rise in daily screen exposure, raising concerns about its potential impact on eye health and the nervous system. Prolonged screen use is associated with conditions such as dry eye disease (DED), computer vision syndrome (CVS), progressive myopia, sleep disturbances, mental fatigue, and screen addiction - especially among children and adolescents.

Material and methods. A narrative review of peer-reviewed articles, systematic reviews, and meta-analyses indexed in PubMed and Google Scholar was conducted. Boolean search strategies combined terms related to digital screens, ocular health, neurocognitive effects, and preventive interventions. Studies published up to 2025, with emphasis on data from 2020-2025, were included. The review focused on both ophthalmological and neurological consequences of screen exposure.

Results. Current evidence indicates a strong correlation between prolonged screen use and the incidence of DED, CVS, and myopia. Neurocognitive impacts include circadian rhythm disruption due to blue light exposure, sensory overload, mental fatigue, and early signs of attentional deficits – especially in younger populations. Screen addiction amplifies these risks. Although some mitigation strategies, such as the 20-20-20 rule and digital detox programmes, have demonstrated effectiveness, others, like blue light filters, show inconsistent results.

Conclusions. Prolonged use of digital screens has been shown to affect both visual and neurological health adversely. While complete avoidance is unrealistic, adopting healthy screen habits and evidence-based preventive strategies is critical. Further longitudinal research is essential to clarify long-term effects and support informed public health recommendations.

Introduction

The modern world is increasingly reliant on digital technology, with screens of electronic devices such as smartphones, computers, tablets, and televisions becoming an integral part of everyday life. These devices are used for work, education, entertainment, and communication, resulting in a steadily increasing amount of screen time [1,2]. According to research, the average user may spend several hours per day in front of digital screens, with this number rising significantly among individuals working remotely or engaging in online learning [3]. This issue was further exacerbated by the Coronavirus Disease 2019 (COVID-19) pandemic, during which people confined to their homes reported an even greater increase in digital screen use [4]. While modern technologies offer many advantages, excessive use has raised growing concerns regarding potential health consequences, particularly in relation to visual health and the nervous system.

Scientific literature increasingly highlights a link between prolonged screen exposure and a variety of health disorders, such as diminished visual quality, chronic fatigue, sleep disturbances, sensory overload, and even neurobiological changes in brain structure and function [5]. A growing concern is also digital device addiction, which may intensify these symptoms and hinder their management. These issues are especially alarming in children and adolescents, whose visual and nervous systems are in a critical stage of development and are therefore particularly vulnerable to environmental stressors [6].

The purpose of this review is to systematically summarise and critically assess the current evidence regarding the effects of prolonged digital screen use on visual and neurological health. Additionally, the review aims to identify key risk factors, highlight gaps in existing research, and present practical, evidence-based strategies to mitigate the adverse health outcomes associated with excessive screen exposure.

Methods

Study design

This narrative review aimed to provide an in-depth overview of the current scientific evidence on the impact of digital screen use on ocular health and the nervous system. The review focused on primary screen-related conditions such as Dry Eye Disease, Computer Vision Syndrome, myopia, circadian rhythm disturbances, sensory overload, and screen addiction.

A literature search was conducted using PubMed and Google Scholar, covering publications up to 2025, with particular emphasis on studies from 2020 to 2025. Older studies were included when recent data were limited or when they provided foundational insights into the studied phenomena.

The inclusion criteria encompassed peer-reviewed original research articles, systematic reviews, meta-analyses, and clinical studies focused on the ocular or neurocognitive effects of digital screen use in both children and adults. Studies addressing interventions and preventive strategies were also included.

Exclusion criteria involved studies unrelated to screen use (e.g., general visual impairment causes, non-digital media exposure), animal studies not directly translatable to human health, and reports lacking primary data (e.g., editorials, non-systematic opinion pieces).

Additionally, reference lists of key publications were manually reviewed to identify further relevant studies. Given the heterogeneity of study designs, outcome measures, and populations, this review did not include a meta-analytic synthesis. Instead, it focused on summarising recurring findings, highlighting contradictory results, and identifying research gaps to inform future investigations.

Risk of bias

As a narrative review, this work lacks a formal systematic review protocol or standardised quality assessment of included studies, which introduces a potential risk of selection bias. Study inclusion was based on the authors' critical judgement rather than predefined methodological scoring systems.

Although efforts were made to ensure comprehensive literature coverage using Boolean strategies across major databases, reliance on English-language publications and selected databases may have resulted in the omission of relevant studies.

The heterogeneity of clinical endpoints, study populations, and methodological approaches limited the possibility of direct comparisons between studies. Therefore, this review provides a qualitative synthesis rather than a quantitative assessment.

Furthermore, the possibility of publication bias cannot be excluded – studies reporting significant or positive findings are more likely to be published, potentially skewing the evidence base. While priority was given to recent research, the exclusion of older studies may have led to under-representation of important historical data.

The authors aimed to maintain a balanced and objective perspective; however, subjective interpretation of study outcomes and emphasis on specific findings may have influenced the narrative. The conclusions presented should be considered as a foundation for further research rather than definitive clinical guidance.

Effects of screens on eye health

This chapter provides an in-depth analysis of the effects of digital screen exposure on ocular health, with a particular emphasis on the prevalence and clinical implications of Computer Vision Syndrome, Dry Eye Syndrome and the rising incidence of myopia.

Dry Eye Syndrome and Dry Eye Disease

Dry Eye Syndrome (DES), or more broadly referred to as Dry Eye Disease (DED), is one of the most common causes of ophthalmologic consultations. It is characterised by insufficient ocular surface lubrication, most commonly due to reduced tear production or excessive tear evaporation. The most frequently reported symptoms include dryness and burning sensations, a foreign body or "gritty" sensation under the eyelids, red and fatigued eyes, blurred vision, and photophobia [7].

According to the Tear Film and Ocular Surface Society, the prevalence of DED ranges from 5% to 50% of the population, occurring more frequently in women and individuals of Asian descent, with age being the most significant risk factor [8]. In addition to non-modifiable risk factors, modifiable contributors have also been identified, most notably excessive use of digital screens [9]. Prolonged screen exposure is associated with a decreased blink rate and an increased frequency of incomplete blinks. These factors contribute to tear film instability, increased evaporation, tear hyperosmolarity, and ocular surface inflammation and damage [10].

Fjaervoll et al. [11] conducted a systematic review in which, following predefined inclusion and exclusion criteria, they selected 57 studies investigating the relationship between digital screen use and the occurrence of DED. Their analysis demonstrated a strong correlation between excessive screen time and the incidence of DED. Notably, they found that even 1–2 hours of screen use per day may contribute to DED-related symptoms [11].

A recent study by Jadeja et al. [12] focused on the paediatric population to assess the impact of screen exposure on the development of DED. Among 462 children examined, 90.5% were diagnosed with DED. The study revealed that moderate and severe DED were significantly associated with higher digital screen use compared to mild DED ($P = 0.001$). Furthermore, screen time exceeding three hours per day markedly increased the risk of DED in children. Additional factors, such as every 30-minute increment of computer use and being in higher school grades (which are associated with more screen-based academic work), were found to significantly increase the likelihood of moderate to severe DED [12].

DED represents a prevalent ophthalmological condition strongly linked to modern lifestyle factors. The studies indicate that even short daily exposures to screens can substantially elevate the risk of DED, especially in children. The rising prevalence in this age group underscores the urgent need for greater awareness and preventative measures, such as limiting screen time and promoting healthy visual habits.

Computer Vision Syndrome

Computer Vision Syndrome (CVS), also known as digital eye strain, refers to a collection of visual and ocular symptoms associated with prolonged use of electronic screens, such as computer monitors, smartphones, and tablets. Contemporary work and lifestyle patterns have led to a significant increase in daily screen time, often resulting in visual strain and a range of related complaints. CVS encompasses symptoms including eye fatigue, dryness, burning sensations, headaches, double vision, blurred vision, and difficulty with accommodation. The primary contributing factors include extended screen exposure under suboptimal lighting conditions, reduced blink rate, excessive exposure to blue light, and poor ergonomic design of the workspace [13,14].

According to a meta-analysis by Anbesu and Lema (2023) [15], the overall prevalence of CVS, based on 45 studies, was found to be 66% in the studied populations [15]. Given the increasing number of individuals affected, CVS has become a significant concern in both ophthalmology and optometry, with potential consequences not only for visual comfort but also for work efficiency and general well-being.

Alamri et al. [16] conducted a questionnaire-based study involving 400 participants to assess symptoms, risk factors, and other aspects related to CVS. Their findings revealed that 9% of respondents reported isolated eye pain, 8% experienced DES, 6% reported tearing and eye redness, 20% exhibited multiple symptoms simultaneously, and 9% were asymptomatic. Notably, 69% of participants reported a worsening of symptoms following the onset of COVID-19 lockdowns [16].

A comparable investigation was carried out by Abudawood et al. [17], aiming to assess the prevalence of CVS symptoms and their associated risk factors among 651 medical students at King Abdulaziz University in Jeddah, Saudi Arabia. The study reported that 95% of respondents (558 individuals) experienced at least one CVS-related symptom while working on a computer. Key risk factors identified included prolonged screen time, close head positioning to the screen, and high screen brightness. The most common ocular symptoms were excessive tearing and dryness, while non-ocular symptoms included neck, back, shoulder, and head pain [17].

CVS represents a growing public health concern affecting a substantial portion of digital screen users. Studies consistently report a high prevalence of CVS and emphasise the role of significant risk factors, such as extended screen exposure, poor ergonomics, and intense screen light. The observed exacerbation of symptoms during pandemic-related lockdowns further underscores the relevance of this condition. Continued research into effective preventive and therapeutic strategies for CVS is crucial for enhancing visual comfort and overall quality of life for individuals exposed to prolonged screen use.

Myopia and its association with digital screen exposure

Myopia, or nearsightedness, is a refractive error in which light rays focus in front of the retina rather than directly on it. This condition results in blurred distance vision while near objects remain clear. Although genetic predisposition plays a role, environmental factors – particularly prolonged near work involving digital screens – may significantly accelerate the onset and progression of myopia [18].

Extended periods of near work with digital devices require sustained accommodation, wherein the eye continually focuses on nearby objects (e.g., a smartphone or computer screen). This persistent engagement of the ciliary muscle can lead to accommodative spasm [19]. Over time, the eye may adapt to near vision at the expense of distance clarity. This phenomenon is especially concerning in children and adolescents whose visual systems are still developing, thereby increasing the likelihood of permanent myopic changes.

Numerous studies have investigated the relationship between digital screen use and the development of myopia. A meta-analysis by Ha et al. [20] found that each additional hour of daily screen time increases the risk of developing myopia by 21%. When analysing the correlation between screen exposure duration and refractive risk, a substantial increase in risk was observed with increasing screen time. The study indicated that exposure of less than one hour per day is associated with low risk, whereas exposure ranging from 1 to 4 hours is linked to a sharp increase in risk. Beyond 4 hours, the risk continues to rise but at a slower, more stable rate [20].

Similarly, a meta-analysis by Zong et al. [21] confirmed a significant correlation between more prolonged digital screen exposure and the risk of developing myopia, compared to shorter durations. The authors reported a 7% increase in myopia risk for every additional hour of daily screen use. Notably, a subgroup analysis examined the influence of specific device types on myopia development. Results indicated that extended use of computers and televisions was significantly associated with increased risk, whereas smartphone use did not show a similar correlation [21]. This discrepancy may stem from typical smartphone usage patterns, which often involve shorter, more intermittent sessions interspersed with rest periods, potentially reducing their cumulative impact on ocular development.

In response to increased screen time among children and adolescents during the COVID-19 pandemic, mainly due to remote learning, AlShamlan et al. [22] conducted a retrospective study demonstrating that the progression of myopia accelerated significantly in these age groups during the lockdown period [22].

In summary, available evidence clearly demonstrates a significant association between prolonged digital screen exposure and an elevated risk of myopia. Moreover, intensive use of digital devices during early life stages – especially during periods of active eyeball growth – may accelerate both the onset and progression of this refractive error. Given the increasing prevalence of screen use among children and adolescents, further research and the implementation of effective preventive strategies are essential.

The impact of screens on the nervous system

This chapter examines the effects of prolonged digital screen exposure on the functioning of the nervous system. Drawing on current scientific research, it discusses potential associations between screen use and sleep disturbances, impaired concentration, increased stress levels, and symptoms of anxiety and depression. Evidence from the literature is presented to support the existence of correlations between the intensity of screen use and alterations in neuropsychological functioning.

Disruption of circadian rhythm and sleep problems

Melatonin is a key hormone involved in maintaining the body's homeostasis, particularly in regulating the circadian sleep-wake cycle. It is primarily synthesised and secreted by the pineal gland and exerts its effects through MT1 and MT2 receptors, which facilitate sleep onset and inhibit arousal-promoting signals. The rhythm of melatonin secretion is regulated by the interaction between the suprachiasmatic nucleus and the retina; secretion increases in response to low-light conditions [23,24].

A growing body of evidence suggests that evening use of screen-based electronic devices—such as smartphones, computers, tablets, and televisions—may impair sleep quality and lead to increased daytime sleepiness [25]. This effect is believed to be associated with the high levels of blue light emitted by modern LED-based digital screens. Blue light, particularly in the wavelength range of 446 to 477 nm, has been shown to exert the most potent suppressive effect on melatonin secretion, thereby disrupting circadian rhythms [26,27].

In a study conducted by Heo et al. [28], the effects of blue light emitted from conventional smartphone LED screens were evaluated in relation to plasma melatonin and cortisol levels, core body temperature, and outcomes on standardised psychiatric tests. The control group used smartphones equipped with blue light-blocking filters. Participants were exposed to the respective device from 19:30 to 22:00, with blood samples and temperature measurements collected before, during, and after the experiment. Results showed that participants using conventional smartphones reported lower subjective sleepiness, greater confusion-bewilderment, and a higher number of commission errors on cognitive performance tasks (as assessed by the Profile of Mood States, Epworth Sleepiness Scale, Fatigue Severity Scale, and auditory and visual Continuous Performance Tests). Additionally, the onset of melatonin secretion under dim light conditions was delayed in these individuals. Although increases in melatonin, cortisol, and body temperature were observed, these changes were not statistically significant. The findings suggest that evening smartphone use can impair sleep onset and increase cognitive errors, particularly commission-type errors [28].

A similar study by Chinoy et al. [29] compared the use of screen-based devices versus traditional reading before bedtime. Consistent with prior findings, participants who used screen-emitting devices reported reduced sleepiness, opted for later bedtimes, and experienced longer sleep latency. Laboratory assessments showed lower evening melatonin levels and delayed onset of melatonin secretion. Moreover, these individuals demonstrated reduced alertness the following day compared to those who read from non-light-emitting sources before sleep [29].

Melatonin plays a crucial role in regulating circadian rhythms through interactions with the MT1 and MT2 receptors. Its secretion is highly sensitive to lighting conditions and particularly susceptible to suppression by blue light. Studies have shown that evening exposure to blue light from LED-based screen devices delays melatonin onset, disrupts sleep patterns, reduces subjective sleepiness, and increases the occurrence of cognitive errors such as commission mistakes. These findings collectively support the conclusion that exposure to blue light negatively affects sleep-wake homeostasis and cognitive functioning.

Sensory overload and mental fatigue

In addition to sleep disturbances caused by excessive blue light exposure and the subsequent suppression of melatonin secretion, the use of screen-based digital devices contributes to sensory overload and mental fatigue. Continuous stimulation from digital cues (e.g., notifications, messages, and rapid visual transitions) may induce a state of mental fatigue, characterised by cognitive exhaustion, lack of energy for mental tasks, and difficulty maintaining attention. Research suggests that sustained digital device use without adequate breaks lowers overall alertness and may trigger symptoms resembling sensory overstimulation, as observed in anxiety disorders [30].

Excessive and frequent use of screens can lead to a phenomenon referred to as 'digital burnout' – a condition of physical and mental exhaustion caused by chronic digital overstimulation [31]. Individuals experiencing digital burnout commonly report persistent fatigue, sleep disturbances, headaches, and emotional symptoms such as apathy, irritability, and heightened anxiety. Mental health professionals have observed a growing number of patients experiencing media overload, including symptoms of information stress related to compulsive monitoring of online news content [32].

An illustrative phenomenon emerged during the COVID-19 pandemic, when social isolation led to increased use of video conferencing platforms, resulting in what is now known as "Zoom fatigue". Ahn et al. [33] conducted a survey study which revealed that prolonged participation in virtual meetings contributed to fatigue, reduced motivation, and elevated stress levels. The causes included cognitive overload (e.g., constant eye contact, self-view monitoring, sustained attention) and the absence of natural breaks and physical movement [33].

Lastly, a study by Nagata et al. [34] demonstrated a correlation between screen time and the prevalence of various behavioural disturbances. It was found that higher overall screen exposure was associated with a small but statistically significant increase in symptoms of depression and Attention-Deficit/Hyperactivity Disorder [34].

Screen use can have adverse effects on mental well-being and cognitive performance. Neural overload may manifest as fatigue, irritability, difficulty concentrating, and reduced efficiency in academic or professional tasks. Modern lifestyles, characterised by continuous technological engagement, are increasingly linked to digital burnout and heightened levels of information-induced stress. These effects were especially pronounced during the COVID-19 pandemic, when daily life shifted even more heavily into the digital realm.

Neurocognitive effects of digital screen exposure

With the growing accessibility and pervasive use of digital devices, increasing scientific interest has been directed toward the impact of screen exposure not only on physical health but also on neurocognitive functioning. The use of screen-based technologies – whether passive (e.g., video viewing) or interactive (e.g., gaming, social media) – has been associated with alterations in neuronal activity, brain structure, and cognitive processing. Recent research efforts have focused on identifying correlations between digital media use and neural patterns observed via electroencephalography (EEG) and magnetic resonance imaging (MRI).

A substantial body of evidence suggests a relationship between excessive screen time and attentional deficits, particularly among children and adolescents during critical stages of neurodevelopment. A longitudinal study demonstrated that children with increased screen exposure at age one exhibited significantly more attention and executive function difficulties by age nine, as assessed through standardised neuropsychological tests and parent-teacher reports. Notably, EEG data revealed early neurophysiological changes as soon as 18 months of age in high screen-time infants, including elevated theta/beta ratios – an established biomarker of hypoarousal and attentional vulnerability [35]. These findings imply that excessive screen-mediated stimulation during early childhood may disrupt normative patterns of attentional development.

In a 2023 EEG study, children with high levels of screen use showed reduced cortical activation during tasks involving attentional control. Specifically, decreased amplitudes of the P2 and P3 event-related potential components were recorded during Go/No-Go paradigms, suggesting diminished efficiency in processing inhibitory cues. This occurred despite no significant differences in response times or accuracy, indicating potential subclinical cognitive alterations [36].

Among young adults, functional MRI studies have identified subtle yet statistically significant differences in intrinsic brain connectivity associated with problematic smartphone use. In one investigation, individuals with elevated scores on smartphone addiction scales exhibited increased static functional connectivity within the frontoparietal control network (implicated in executive functions) and decreased dynamic variability within attentional networks. These patterns may reflect reduced cognitive flexibility and impaired attentional switching mechanisms potentially underlying compulsive engagement with digital devices [37]. Although intergroup behavioural differences were modest, the neuroimaging data suggest that excessive smartphone use is associated with functional reorganisation of brain networks.

Collectively, the current literature indicates that intensive exposure to screen-based media may alter neurocognitive function, particularly in domains related to attention, executive control, and cognitive flexibility. These effects appear to be most pronounced during neurodevelopment windows in childhood and adolescence. While such changes may not be overtly observable in behaviour, advanced neuroimaging methodologies provide robust evidence of disrupted neural processes and information integration mechanisms as a consequence of excessive digital stimulation.

Screen addiction

The rapid development of digital technologies and the widespread availability of screen-based devices have significantly altered the daily functioning of modern individuals. Increasingly, excessive and difficult-to-control screen use is being recognised as exhibiting features characteristic of behavioural addiction. This trend has intensified notably since 2010, coinciding with the proliferation of communication technologies, and accelerated even further after 2020, following the global shift to remote interaction during the COVID-19 pandemic [38]. A central role in this process is played by the brain's reward system, particularly dopamine, a key neurotransmitter involved in the experience of pleasure, motivation, and learning [39]. This subsection aims to explore the impact of screen use on the risk of addiction and the intensification of screen-related behavioural symptoms.

A significant risk factor for screen addiction is high exposure to digital screens during early developmental periods. The American Academy of Paediatrics recommended that children under the age of two should not be exposed to screens at all, children between the ages of two and five should be limited to a maximum of one hour per day, and those over five years of age should not exceed two hours of daily screen time [40]. Similar limitations were included in the 2019 World Health Organisation (WHO) guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age [41]. Tekeci et al. [42] investigated the impact of increased screen exposure on digital screen addiction, measured using the Problematic Media Use Scale, as well as behavioural disorders in children aged 6 to 10. Children were divided into groups based on daily screen time: more than 2 hours versus less than 2 hours. The high-exposure group demonstrated significantly greater rates of screen addiction, attentional difficulties, and sedentary behaviour. These findings underscore the need to limit screen exposure in developing children.

Screen addiction also exacerbates other adverse effects associated with excessive screen use, as individuals with addictive tendencies spend more time in front of screens, particularly in the evening. This was confirmed in a large-scale Norwegian survey involving 49,051 university students. The study found that participants exhibiting signs of screen addiction were more likely to engage with digital devices in the evening and experienced greater disruptions in both the quantity and quality of sleep compared to non-addicted individuals. Notably, the severity of these disruptions was directly proportional to the degree of addiction. The findings suggest that screen addiction negatively affects psychophysical health, with evening use being especially detrimental to sleep regulation, more so than excessive daytime use. Digital screen use exerts multifaceted adverse effects, and addiction further amplifies its impact on health [43].

Screen addiction is a complex process underpinned by neurobiological mechanisms, particularly those involving dopaminergic signalling. This issue is increasingly prevalent among children and adolescents and is associated with sleep disturbances, attentional deficits, and the adoption of sedentary behaviours. Evening exposure to screens further exacerbates these adverse outcomes. Given the growing prevalence of this phenomenon, the implementation of preventative and educational interventions is critical to mitigating the risk of addiction and its long-term consequences for mental health and the functioning of the nervous system.

Minimising the negative effects of screen use

In light of the growing body of evidence documenting the negative impact of digital screen use on human health, preventive measures and mitigation strategies have become increasingly important. While complete avoidance of screen-based devices is unrealistic in modern society, adopting healthy digital habits is both feasible and strongly recommended. Such practices can help reduce the risk of visual disturbances, sleep disorders, mental fatigue, and behavioural addiction.

This subsection presents evidence-based, practical approaches to minimising the adverse outcomes associated with prolonged screen exposure. These include digital detox protocols, the use of blue light filters, making proper ergonomic adjustments in the workspace, and incorporating regular breaks during screen use. The implementation of these strategies aims to support physical and mental well-being in a digitally saturated environment.

20–20–20 rule

One of the simplest and most effective strategies for mitigating the adverse visual effects of screen exposure is the 20–20–20 rule (see **Figure 1**). Initially proposed by Anshel [44] in the late 1990s, the rule recommends that every 20 min-

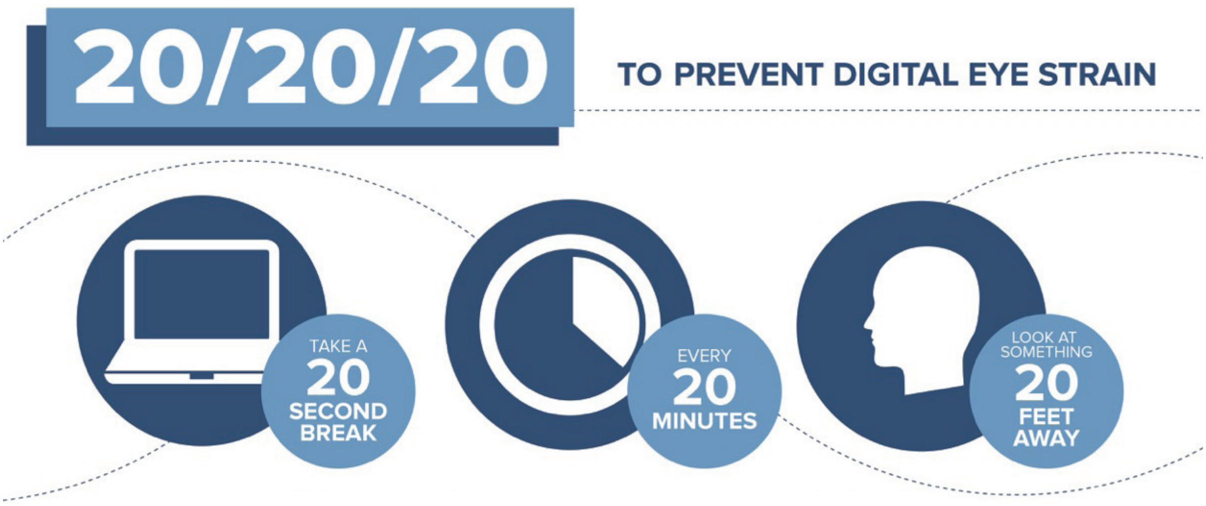

Figure 1. The 20–20–20 rule, as recommended by the American Optometric Association, is to reduce digital eye strain. Source: American Optometric Association, www.aoa.org

utes of screen use be followed by a 20-second break, during which the user focuses on an object at least 20 feet (approximately 6 metres) away [44,45]. This method has gained widespread recognition among ophthalmologists and occupational health professionals as an effective preventive tool for CVS.

The efficacy of the 20–20–20 rule has been investigated in multiple studies. For example, Talens-Estarelles et al. [46] conducted a study in which participants (n = 29) used a software application that provided reminders to take breaks according to the 20–20–20 guideline. Results demonstrated a reduction in symptoms of CVS and DES during the intervention period. Notably, these symptoms returned within two weeks after discontinuation of the method, suggesting a direct link between adherence and symptom control [46].

In another study, researchers divided participants diagnosed with CVS into two groups: one was instructed to follow the 20–20–20 rule, while the control group received no such intervention. The experimental group showed significant improvement in both subjective symptoms and tear film quality, further supporting the clinical relevance of this strategy [47].

Regular implementation of the 20–20–20 rule helps alleviate ocular muscle tension, prevent corneal dryness, and support the eye's natural accommodative mechanisms, thereby reducing the risk of long-term visual impairment associated with prolonged digital device use.

Blue light filters and night modes

Modern digital screens emit a considerable amount of blue light (wavelengths between 400–490 nm), which has been shown to disrupt circadian rhythms, impair sleep quality, and negatively affect visual comfort, particularly during prolonged screen use in the evening hours. In response to health concerns related to blue light exposure, a growing number of mitigation strategies have been introduced. These include both physical blue light filters, such as specially coated lenses, and digital solutions like Night mode available on most electronic devices. However, the actual effectiveness of these interventions remains under scrutiny.

A systematic review by Singh et al. [48] investigated the efficacy of blue light-filtering lenses. The results raised questions about their clinical relevance. Specifically, no significant differences were found in the reduction of CVS symptoms when compared to standard lenses. Similarly, the impact on sleep quality was inconclusive – approximately half of the included studies reported subjective improvement, while the other half found no statistically significant effects [48].

The use of night-mode features on digital devices has also yielded mixed findings. Two separate studies involving smartphone and tablet users demonstrated that activating night mode alone, without concurrently reducing screen brightness, had no measurable effect compared to everyday device use. Only when screen brightness was decreased in conjunction with night mode did researchers observe a positive impact on endogenous melatonin production [49, 50].

Currently, there is insufficient evidence to support the widespread assumption that blue light-filtering lenses or built-in night-mode features provide significant benefits in terms of reducing eye strain, improving visual acuity, enhancing sleep quality, or optimising other visual parameters. Further high-quality, controlled studies are needed to determine the actual effectiveness of these technologies.

Ergonomic practices for digital screen use

The ergonomics of digital screen use play a critical role during prolonged interaction with electronic devices. A well-designed workstation can significantly reduce the risk of discomfort and disorders related to visual strain and musculoskeletal overload. In Poland, the first regulations concerning occupational safety and health for screen-based workstations were introduced in 1998, and in 2023, these regulations were updated to reflect the current realities of computer-based work environments [51,52].

Key ergonomic recommendations include using appropriate ambient lighting, positioning the monitor at eye level and a comfortable viewing distance, and allowing for adjustable screen tilt angles. Equally important is maintaining a proper seated posture, supported by an adjustable ergonomic chair, along with a workstation layout that allows for natural arm positioning while using a keyboard and mouse. For individuals using a laptop for extended periods, the addition of an external monitor, keyboard, and mouse becomes essential to maintain ergonomic integrity.

Another crucial element of preventing visual fatigue and physical strain is the incorporation of regular work breaks. According to occupational health guidelines, at least a five-minute break should be taken after each hour of computer use. Additionally, implementing the 20–20–20 rule offers a practical and time-efficient strategy for preserving visual health.

Adherence to ergonomic principles not only minimises the adverse effects of prolonged screen exposure but also promotes overall well-being and supports both physical and mental health in screen-intensive environments.

Reducing exposure to digital devices

While numerous strategies exist to mitigate the adverse effects of digital screen use, the most effective, yet arguably the most challenging to implement, remains a reduction in overall screen exposure. Although the modern lifestyle makes complete avoidance of screen-based technologies unrealistic, even partial reductions, particularly during critical times of day, can yield measurable benefits for health and well-being.

One practical example involves minimising digital device use during evening hours. A study conducted at the University of Oxford demonstrated that restricting screen use among adolescents after 9:00 p.m. led to earlier sleep onset and increased total sleep duration, which in turn improved alertness and daily functioning [53]. Similarly, a study involving adult participants found that avoiding screen use for 30 minutes before bedtime resulted in shorter sleep latency and longer and higher-quality sleep, as well as improved mood and working memory performance compared to a control group [54].

Another promising approach is the practice of digital detox, defined as intentional and scheduled breaks from the use of electronic devices and digital media [55]. Studies have shown that such digital abstinence can reduce symptoms of anxiety and depression [56], as well as lower levels of digital media dependency [57].

Although total avoidance of digital screens is virtually unattainable in today's world, even modest reductions in screen time, especially before bedtime, and periodic disconnection from electronic devices may significantly enhance sleep quality, psychological well-being, and overall cognitive functioning.

Limitations

Despite the growing body of research on the effects of digital screen exposure on visual and neurological health, key limitations persist. Most studies are observational or cross-sectional, limiting causal inference. While associations with dry eye disease, myopia, or sleep disturbances are well-documented, causation remains speculative, and potential confounders—such as genetics, outdoor activity, or lifestyle—are often inadequately controlled.

Existing research also focuses mainly on short- to medium-term effects, with a notable lack of longitudinal studies assessing the lasting impact of chronic screen exposure on ocular health and neurodevelopment.

Moreover, screen use is frequently measured by total daily time, neglecting qualitative factors like content type, interaction mode, or context, all of which may influence health outcomes.

Generalisability is further limited by narrow study populations, often confined to specific regions or age groups. Older adults, patients with comorbidities, and diverse cultural contexts remain under-represented.

Addressing these gaps through robust, prospective studies will be crucial in informing evidence-based guidelines. Notably, the potential link between prolonged screen exposure and neurodegeneration remains an open area for future research.

Conclusions

The ongoing digitalisation of daily life, education, and professional activity has rendered exposure to electronic screens virtually unavoidable. While technology offers numerous benefits, its excessive and unregulated use is increasingly associated with significant health risks. This in-depth review of the scientific literature suggests that prolonged screen exposure has adverse effects on both the visual and nervous systems.

From an ophthalmological perspective, Dry Eye Disease, Computer Vision Syndrome, and progressive myopia remain the most significant screen-associated disorders. Evidence confirms that even short-term daily screen use may disrupt tear film stability, strain accommodative mechanisms, and increase the risk of refractive changes – particularly in children and adolescents.

Regarding the nervous system, prolonged exposure to screen-emitted blue light impairs circadian rhythms and sleep quality. Furthermore, continuous sensory and cognitive stimulation from digital content can contribute to mental fatigue and attention deficits and may also influence brain activity patterns. These effects appear particularly pronounced among younger populations. The growing phenomenon of screen addiction further exacerbates these risks, potentially leading to emotional dysregulation and behavioural disturbances.

Although complete avoidance of digital devices is neither realistic nor necessary, it is both possible and imperative to implement preventive strategies aimed at mitigating these adverse health effects. This review highlights practical, evidence-based measures, including ergonomic interventions, visual hygiene practices such as the 20–20–20 rule, limiting screen time before bedtime, and promoting digital detox habits.

Given the interdisciplinary impact of digital screen exposure, healthcare professionals, including ophthalmologists, neurologists, psychiatrists, and primary care physicians, should be aware of its multifaceted health implications. Incorporating preventive counselling on screen time management and digital hygiene into routine clinical practice may offer tangible benefits for patient well-being.

Future research should explore how different types of screen content and modes of interaction – such as passive viewing versus active engagement – affect visual and neurological health. Equally important is the need for longitudinal studies evaluating the long-term impact of chronic screen exposure across various populations and age groups. Such evidence is crucial for guiding public health strategies and informing evidence-based policy in an increasingly digital world.

Glossary

Accommodation – The eye's ability to adjust focus between near and distant objects.
Accommodative spasm – A temporary focusing problem after prolonged near work.
Blue light – High-energy light from screens that can interfere with sleep and cause eye strain.
Blue light filter – A screen setting or lens coating that reduces blue light exposure, especially in the evening.
Circadian rhythm – The body's internal 24-hour cycle that regulates sleep, alertness, and hormone release.
Digital burnout – a state of mental and physical exhaustion resulting from prolonged screen use and constant connectivity.
Digital detox – A planned break from digital devices to reduce stress and improve well-being.
Dopamine – A brain chemical involved in motivation and reward, linked to habit formation and screen addiction.
Electroencephalography (EEG) – A method for recording brain activity using electrodes on the scalp.
Ergonomics – The science of designing comfortable and health-supportive work environments, especially during screen use.
Functional MRI (fMRI) – A brain scan that detects active areas based on blood flow during tasks or rest.
Melatonin – A hormone that promotes sleep, often suppressed by evening exposure to screen-emitted blue light.
Myopia – A vision condition (nearsightedness) where distant objects appear blurry.
Photophobia – Sensitivity or discomfort when exposed to bright light.
Reward system – A group of brain structures that regulate pleasure, motivation, and reinforcement behaviour.
Screen addiction – Excessive and compulsive screen use that negatively affects health and daily functioning.
Sensory overload – Feeling overwhelmed by too much visual, auditory, or informational input.
Zoom fatigue – Tiredness and concentration difficulties caused by prolonged video conferencing.

Disclosures

Author contribution statement
All authors contributed equally to every aspect of the development of this research paper, including conceptualisation, investigation, project administration, visualisation, writing – original draft, and writing – review & editing. All authors have read and agreed with the published version of the manuscript.

Funding statement
This research did not receive any external funding.

Institutional review board statement
Ethical review and approval were waived due to the review nature of this study.

Informed consent statement: not applicable.

Data availability statement: not applicable.

Acknowledgements
The authors do not have anyone to acknowledge.

Conflict of interest statement
The authors declare that they have no conflicts of interest.

Declaration of the use of generative AI and AI-assisted technologies
In the preparation of this work, the authors used OpenAI for the purpose of improving language and readability, text formatting, and verification. After using this tool/service, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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