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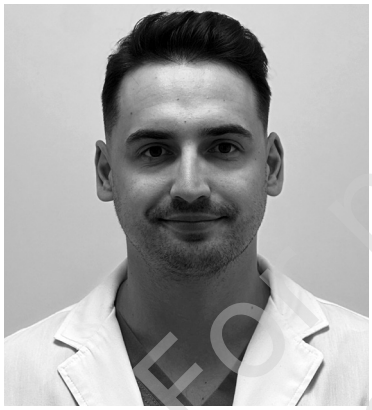
Digital eye strain – myth or reality?



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HIGHLIGHTS

The digital revolution has brought benefits, but also health challenges – including dry eye syndrome – which require appropriate preventive measures, social awareness, and attention to digital hygiene.

ABSTRACT

The digital revolution has led to a rapid increase in the popularity of digital technologies, transforming every aspect of life. Technological advancements and frequent use of electronic devices have resulted in vision problems known as computer vision syndrome or digital eye strain. Digital eye strain, asthenopia, and computer vision syndrome are a group of symptoms arising from the use of digital screens; these include eye irritation and dryness, accommodation and convergence issues, and musculoskeletal pain. The severity of these symptoms depends on exposure time, the nature of visual tasks, working conditions, and individual visual capabilities. Treatment for digital eye strain depends on diagnostic results and underlying conditions, and all symptoms, such as asthenopia or poor ergonomic setup, should be addressed according to professional guidelines. The purpose of this paper is to present the issue of digital eye strain and propose solutions that can help diagnose and effectively combat its symptoms.

Key words: digital eye strain, dry eye syndrome, vision disorders

INTRODUCTION

The digital revolution, also known as the third industrial revolution, began in the 1980s. This period saw a rapid increase in the popularity of digital technologies – ATMs, industrial robots, electronic music, video games, and computer-generated images in films and television became part of everyday life [1]. Technology has transformed every aspect of our lives, from healthcare to education. Electronic devices such as computers, tablets, iPads, and smartphones have become integral to our daily routines. With internet browsers, we have constant access to information, can easily locate resources, and save them on our computers or smartphones, reducing our reliance on paper materials. Fast and efficient communication, broad access to information, and the abandonment of paper documents are just a few benefits of the modern digital reality [2–4].

As technological advancements and frequent use of electronic devices have increased, so have vision-related issues, defined as computer vision syndrome (CVS), also known as digital eye strain (DES).

METHODOLOGY

This study concentrates on a comprehensive analysis of the available scientific literature concerning DES. The objective is to identify key aspects of this problem by analysing current knowledge and determining factors influencing its development. Furthermore, methods for preventing and treating DES are described. To accomplish this, we searched scientific databases, identified key terms and concepts related to DES, and applied the above methodology to obtain a complete picture of the current state of knowledge on DES.

LITERATURE REVIEW

CVS, also known as DES, describes a group of eye and vision problems resulting from prolonged use of computers, tablets, e-readers, or mobile phones [5]. Nearly 75% of daily human activities involve computer use. The sudden increase in time spent using digital devices and the overall number of hours spent in front of screens daily result from the shift of professional and social activities to electronic platforms [6]. Globally, the number of internet users has dramatically increased. In 2005, there were just over a billion users, while by 2022, over 5 billion people had access to the internet [7]. This number continues to rise, and by October 2023, 5.3 billion people had internet access, representing 65.7% of the global population [8]. At the end of 2019, a COVID-19 epidemic broke out in Wuhan, which was declared a pandemic by the World Health Organization (WHO) on March 11, 2020. WHO's social distancing recommendations initiated various actions to control and limit the spread of the SARS-CoV-2 virus [9]. The pandemic led to restrictions not only in schools and offices but also outdoors, causing numerous inconveniences. As a result, people worldwide adapted to the situation by using alternative ways to spend time, both at work and during leisure. The closure of offices and workplaces led to increased remote work and participation in online meetings and video conferences, resulting in extended screen time on computers and phones.

To avoid gatherings and maintain social distancing, numerous webinars were organized online. The restriction on outdoor activities led people to seek alternative forms of entertainment at home, such as video games, television, and online streaming platforms. Due to the lack of opportunities for physical interaction, there was an increase in the use of smartphones and other digital devices necessary for social media, video calls, and online shopping. Schools and universities were completely closed, and students were provided with alternative sources of knowledge, mainly accessible through the internet [10–12]. Ccami-Bernal and colleagues conducted studies that defined CVS as a set of eye and vision symptoms resulting from prolonged use of computers, tablets, e-book readers, and mobile phones. Their search was conducted in databases including PubMed, SCOPUS, EMBASE, and Web of Science/Core. The study involved 66,577 participants with ages ranging from 9.7 to 54.7 years. The sample included workers (mainly office, IT, or university staff), students, children and youth, and the general population. Common ophthalmological symptoms used in CVS diagnosis included blurred vision (92%), dryness (92%), and eye redness (86%), as well as tearing (81%). Additionally, extragastric symptoms like headaches (91%), neck pain (34%), shoulder pain (28%), and back pain (17%) were noted. CVS was more frequent among contact lens wearers [13]. Even up to 85% of contact lens wearers experienced at least one symptom related to dry eye, compared to up to 71% among those not wearing contact lenses [14]. The presence of a contact lens on the eye's surface can cause changes in the tear film and discomfort in adjacent areas, such as the cornea, conjunctiva, or eyelids. Regarding gender, Ccami-Bernal and colleagues found that CVS was more common in women (71.4% vs 61.8%), consistent with most previous studies on DES. In defining DES, most studies considered a broad range of symptoms, but it remains unclear which symptoms should be considered for diagnosis and how many are necessary for a diagnosis.

It was expected that studies conducted during the pandemic would show a higher incidence of DES. However, this review paradoxically concluded that the frequency of DES was lower during the pandemic. This might have resulted from the fact that although device usage time increased, conditions during lockdown were different. Further research is needed to assess the effectiveness of other proposed measures, such as artificial tears, ergonomic optimization, proper lighting, and frequent breaks to reduce CVS [13, 15].

TABLE 1

The objective symptoms of Computer Vision Syndrome [13].

Number of studies (N = 103)	Objective Symptoms
95	Blurred vision
95	Dryness sensation
94	Headache
89	Redness
84	Tearing
83	Burning sensation
81	Double vision
68	Eye pain
62	Itching
59	Photophobia
57	Difficulty seeing up close

SYMPTOMS ASSOCIATED WITH DIGITAL EYE STRAIN

CVS, asthenopia, and CVS are terms found in literature referring to a group of symptoms related to the discomfort experienced while viewing content on various digital screens and displays.

Symptoms associated with CVS can be divided into three categories:

1. Symptoms related to the surface of the eyeball – caused by the drying of the eye surface due to reduced blinking frequency during prolonged viewing of digital device screens. These symptoms typically include eye irritation, burning, dryness, eye fatigue, and sensitivity to bright light.
2. Symptoms related to accommodation or convergence – these symptoms are caused by excessive computer use and are associated with accommodation and binocular vision disorders. They include blurred vision at near or far distances when using digital devices, difficulty in refocusing from one distance to another, or double vision. Symptoms occurring during digital device use may be related to changes in the accommodation system, including changes in accommodation accuracy, flexibility (accommodation capability), and/or amplitude.
3. Extraocular symptoms – these symptoms include musculoskeletal issues that can cause discomfort in daily activities. They encompass bodily discomfort, such as headaches, neck pain, shoulder pain, or back pain. These symptoms are associated with poor posture resulting from improper placement of computer screens, incorrect desk or chair height, or incorrect eye-screen distance. This leads to unnecessary stretching or leaning forward, resulting in muscle problems.

The intensity and type of symptoms experienced depend on the duration of exposure, the nature of the visual task, environmental factors at the workplace, and the individual's visual abilities [2].

DIAGNOSTIC PROCEDURES

Proposed diagnostic procedures should relate to the symptoms reported by patients. Therefore, clinicians should examine patients for dry eye syndrome. They should ensure that no eye disease has been overlooked or improperly treated, while also informing patients about proper workplace ergonomics.

This assessment would involve standard procedures for evaluating eye motility and strabismus, testing convergence insufficiency, near point of accommodation, accommodative response, and amplitude. There are increasingly more new methods of non-invasive diagnostics for dry eye syndrome, which are expected to be more helpful than less reliable or repeatable tests like the tear break-up time (TBUT) or Schirmer's test. These new methods include non-invasive tear break-up time, thermography, optical coherence tomography of the anterior segment, meibography, interferometry, in vivo confocal microscopy, and assessment of dynamic visual acuity.

It is necessary to reassess refraction. Minor refractive errors can exacerbate symptoms. Meanwhile, uncorrected presbyopia in adults over 40 years old may be diagnosed for the first time during an examination for DES complaints. Symptoms related to posture are more difficult to assess outside the work environment, and the emergence of portable screen devices has further complicated the evaluation and control of this factor. Patients can be instructed to measure various ergonomic desk variables, such as distances from the screen and the relative height of the line of sight and screen. However, other related parameters, including the relative angle of the screen, ambient lighting, and reflections, are difficult to assess [15–17].

TREATMENT

In all reviews, there is consensus that the treatment of DES depends on the results of diagnostic procedures and underlying conditions; the presence of asthenopia, dry eye syndrome, any uncorrected vision problems, or poor ergonomics should be addressed according to established professional guidelines. However, prevention is crucial, as most symptoms can be avoided, and treating symptoms without removing their primary causes will lead to a recurrence of the condition [15–17].

The American Academy of Ophthalmology, in the context of treating and preventing DES, suggests the following methods to alleviate eye strain:

1. Blinking – to prevent eye dryness, it is recommended to blink more frequently. The normal frequency is about 15 times per minute, but when using digital devices, it can decrease to 5-7 times. Regular blinking helps maintain proper eye hydration.
2. Artificial tears – to combat eye dryness, especially in dry environments, artificial tears can be used. Considering the purchase of a humidifier is also a good solution.
3. 20–20–20 rule – after every 20 minutes of working on a digital device, take a 20-second break and look at an object at least 20 feet (6 meters) away from the screen. This allows for relaxation of accommodation, better blood flow, and oxygenation of the ciliary muscles.
4. Computer glasses – for individuals spending many hours in front of computer screens, glasses with lenses corrected for screen distance can reduce eye strain. It's worth noting that glasses with blue light filters are not the same as computer glasses.
5. Adjusting brightness and contrast – to reduce eye strain, the screen brightness should be adjusted to match the ambient light level. Additionally, increasing the screen contrast can be beneficial.
6. Reducing reflections – using a matte screen protector can help reduce reflections, which may contribute to eye strain.

People wearing contact lenses may experience increased eye dryness. It is recommended to wear glasses instead of contacts during prolonged use of digital devices and avoid sleeping in lenses, even if they are designed for overnight wear.

IMPACT OF VIRTUAL REALITY

Using virtual reality (VR) goggles or watching 3D movies can be particularly straining for the eyes due to the need for continuous adjustment of focus. Individuals with exophoria or esophoria may experience specific discomfort when using these technologies.

Adhering to these recommendations can help reduce the discomfort associated with prolonged use of digital devices, which is important considering their widespread presence in daily life [18].

ADDITIONAL STRATEGIES

A comprehensive approach to treating DES involves modifying the work environment and tailoring treatment to individual patient needs. These methods aim not only to reduce existing symptoms but also to prevent their future occurrence [19]. In addition to the basic methods presented above, it is worth considering other, often less obvious aspects of managing this condition. Here are a few additional, useful ways to cope with DES:

1. Adjusting screen brightness and contrast – optimizing screen settings can significantly reduce eye strain. The screen brightness should be adjusted to match the ambient light, which reduces eye tension caused by constant adaptation to different light levels.
2. Using night mode or blue light reduction mode – many modern digital devices offer modes that automatically reduce blue light emission in the evening. These modes can decrease overall eye fatigue and improve sleep quality for users who use them before bedtime.
3. Applying appropriate fonts and text size – reading text on a digital device can be less straining if the text is sufficiently large and easy to read. Many devices allow adjusting font size and style, which can help reduce eye tension.
4. Frequent breaks – in addition to using the 20–20–20 rule, it's also beneficial to organize regular breaks from digital devices. This allows the eyes to rest more fully. For example, you can use apps that remind you to take breaks and completely block the screen during that time.
5. Proper diet and supplementation – a diet rich in vitamins and nutrients that support eye health, such as lutein, zeaxanthin, and B vitamins, can also help reduce eye fatigue symptoms. Additionally, omega-3 supplements can support the health of the tear film, which is beneficial for people suffering from dry eyes due to prolonged screen time.
6. Relaxation exercises for the eyes – besides blinking, there are other exercises that can help relax the eye muscles, such as looking into the distance for a few seconds or making eye movements in different directions. These techniques can contribute to reducing eye tension caused by prolonged focus on close distances.
7. Proper body posture – an ergonomic posture while working with digital devices can also contribute to reducing eye fatigue. The appropriate height of the chair and desk, as well as proper monitor placement at eye level, can decrease tension in the eyes, neck, and back.

By implementing these additional strategies, you can more effectively manage DES and improve overall comfort when working with digital devices [15].

CONCLUSION

The development of digital technology has not only simplified many aspects of life but also opened new opportunities in fields such as education, medicine, and business. Widespread access to information has made knowledge more accessible and its management more efficient. However,

this progress has also brought challenges, including an increase in health risks, such as CVS, also known as DES. As research has shown, prolonged screen time on computers and other digital devices is associated with negative effects on eye health, requiring greater public awareness and the implementation of appropriate preventive and therapeutic measures.

In light of the discussed issues, responsible use of technology becomes increasingly important. It is crucial to exercise caution against uncritical trust in scientific inventions and remember the need to ensure appropriate ethical frameworks that will accompany technological development. Therefore, we must confront the fact that the world in which people currently live is an increasingly digital environment, which brings both benefits and challenges. With proper awareness and the ability to manage technology effectively, it will be possible to more effectively utilize its potential to achieve positive changes.

Undoubtedly, the future will bring new discoveries and technological solutions aimed at both improving the quality of life and reducing the negative effects of prolonged use of digital devices. It will be important to continue research that allows for a deeper understanding of the impact of the digital revolution on human physical and mental health, as well as the development of medical interventions that can minimize these risks.

In summary, although the digital revolution brings numerous benefits, it is necessary to consider both the positive and negative aspects of digitization. A vision of a future where technology serves humanity without dominating it requires cooperation, responsibility, and above all, openness to change from all of us.

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Piotr Nesterowicz: introduction, purpose and methodology, analysis of the literature, conclusion, coordination of the work; Małgorzata Różycka: additional strategies, support in literature search, making editorial corrections; Katarzyna Różycka, Krystian Bakalarski: treatment, impact of virtual reality; Kacper Kranc, Katarzyna Ulaszewka Alan Chamernik: CVS symptoms and table, diagnosis, Polish and English summary; Radosław Różycki: factual consultant.

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The content presented in the article complies with the principles of the Helsinki Declaration, EU directives and harmonized requirements for biomedical journals.