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THE CONVERGENCE OF DIGITAL EYE STRAIN AND DRY EYE DISEASE – A NARRATIVE REVIEW

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ABSTRACT

Background: The surge in digital device usage has contributed to a global rise in Digital Eye Strain (DES) and Dry Eye Disease (DED), both of which are public health concerns. Prolonged screen exposure, reduced blink rates and poor ergonomics are major contributing factors, further intensified by the COVID-19 pandemic **Method:** A comprehensive literature review was conducted using databases like PubMed, Google Scholar and Cochrane. Keywords such as "Digital Eye Strain, ""Dry Eye Disease," and "COVID-19 and visual health were used to identify studies from 2000–2024. **Results:** Studies show that DES and DED are closely linked, with increased screen time leading to a higher prevalence of both conditions. Preventive strategies like the 20-20-20 rule and ergonomic adjustments were effective in reducing symptoms. **Conclusion:** Addressing the convergence of DES and DED is crucial for improving ocular health in a digital world. Early diagnosis and lifestyle modifications are key to mitigating symptoms and enhancing quality of life.

KEYWORDS: Digital Eye Strain (DES), Dry Eye Disease (DED), Computer Vision Syndrome (CVS), Screen time, Ocular health, COVID-19, Eye strain.

INTRODUCTION

Digital media use from online gaming to purchasing medicines has revolutionized societies worldwide. The widespread use of digital devices such as smartphones, tablets, laptop have become ubiquitous, more so among the youth now-a-days. Regardless of the convenience and the entertainment these gadgets offer, there's a growing concern with respect to their potential impact on vision. The use of electronic devices has even more increased post COVID-19 as lockdown was implemented when majority of people used digital devices communication, interaction and their job which was continued as a new way of work called "Work from home" culture which prevails even now.[1] During the pandemic, adults as well as the members of working class have been utilizing video conferencing platforms such as Zoom and Google Meet more frequently for online learning and work related queries.[1] However youngsters have also been similar platforms for lectures and study materials. Apart from that, children's usage of digital device usage has substantially grown. Their usage even for three hours per day, leads to health risk of developing Occupational Overuse Syndrome (OOS), Computer Vision Syndrome (CVS), Low back pain, tension headaches and psychological stress.[2] The 2016 Digital Eye Strain Report, which analysed survey data from more than 10,000 American individuals, found that the total self-reported prevalence was 65%, with women more likely than men to be afflicted (69% vs. 60% prevalence).[3] A report by the Vision Council in 2016 noted that in the USA, approximately two-thirds of adults aged 30– 49 years spend five or more hours on digital devices.[3] DES was present in 78% of individuals overall, and they reported having at least one DES-related symptom.[4]

SEARCH CRITERIA

A literature search was done using PubMed, Google Scholar and Cochrane DataBase. The search was done using the key terms ''dry eye disease'' ''computer vision syndrome'' "dry eye in young population" "Digital Eye Strain", "Computer Vision Syndrome", "Dry Eye Disease", "Digital device usage", "COVID-19 and eye health", and "Work-from-home and visual health".The search was identified from 2000-2024 focused on peer review article, systematic review, literature reviews, articles from government journals , websites were included. (Figure 1)

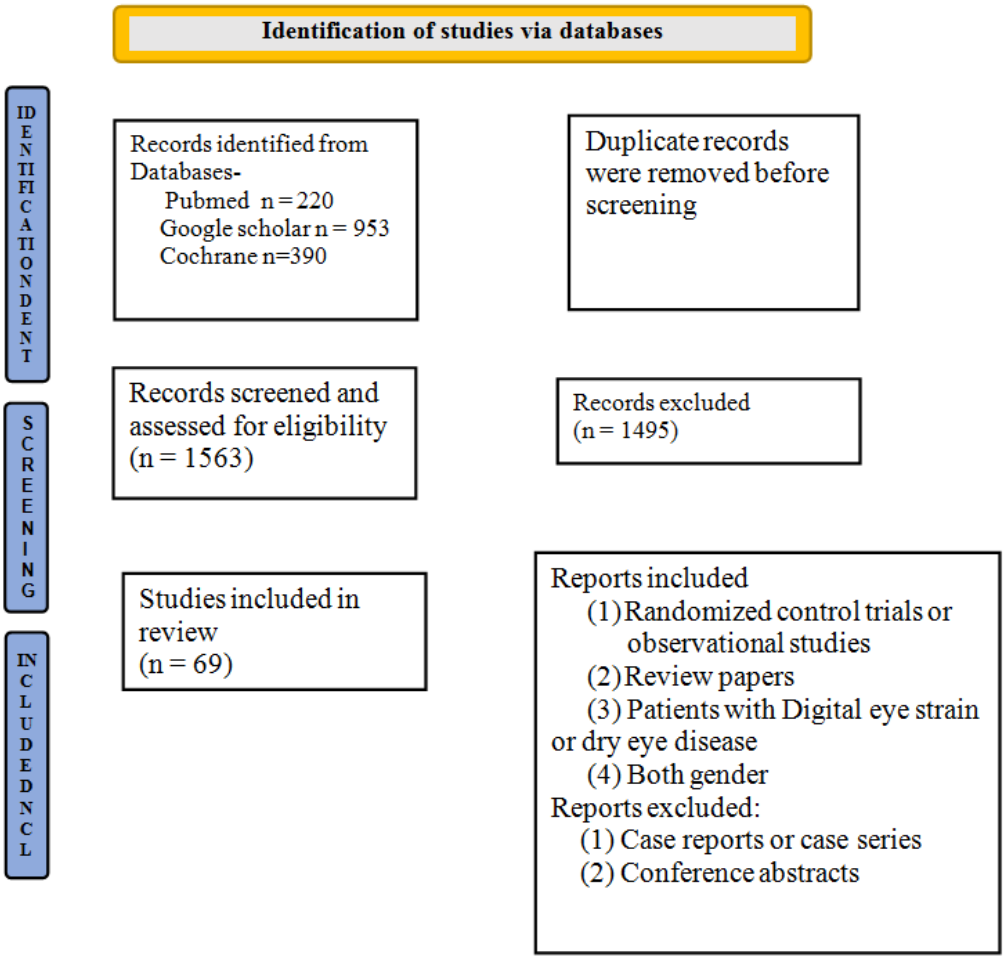


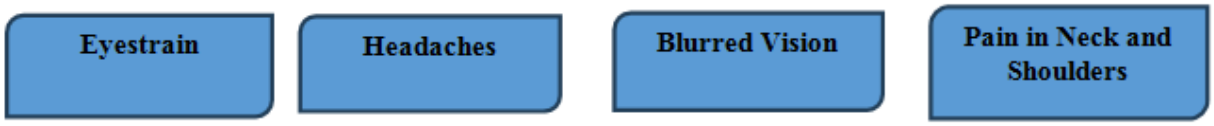
Figure 1: Flow Diagram of Literature Selection Process.

DIGITAL EYE STRAIN

Long-term use of computers, tablets, e-readers, and mobile phones can cause Digital Eye Strain (DES), often referred to as Computer eyesight Syndrome (CVS), a collection of issues affecting the eyes and eyesight.[5] The community's prevalence of digital eye strain varies from 22.3% and 39.8%. The majority of adults with symptoms of digital eye strain (73%) are under 30 years old. Digital eye strain is a new public health concern that increases with the amount of time spent in front of a digital screen.[6]

SYMPTOMS

According to the American Optometric Association, the most common symptoms are:



Eye strain, officially known as asthenopia, has two different causes and sets of symptoms[7] Dry eye was found to be closely associated with external sensations of burning, irritation, tears, and dryness, whereas accommodative and/or binocular vision stress was associated with interior symptoms of strain, discomfort, and headache behind the eyes[8] additionally found that the symptoms of computer use could be clearly divided into two groups: those related to accommodation (such as blurred vision up close, blurred distance vision after using a computer, and trouble focussing from a distance) and those that appeared to be related to dry eye (dry eyes, eyestrain, headache, irritated/burning eyes, sensitivity to bright lights, and eye discomfort).[8]

PREVALENCE

For more than 20 years, the scientific literature has focused on the prevalence of DES. The large diversity of usage conditions (both social and vocational) and significant variations in over time, as well as the variety of methods used to identify sufferers, make it difficult to gauge prevalence. According to recent data that is typical of modern devices and usage patterns, DES is a widespread issue that impacts millions of people.[3]

Table 1: Studies on Digital Eye Strain Prevalence.

Study	Findings	Observations
2016 Digital Eye Strain Report (10,000+ US Adults)[9]	Overall DES prevalence at 65%, with females more affected (69%) than males (60%).	Higher prevalence among individuals using multiple devices (75%) vs single device users (53%).
2012 Study on NY Office Workers (520 participants)[8]	Higher prevalence of DES symptoms in females, suggesting possible gender-specific factors.	Linked to gender differences in dry eye prevalence.
Spanish Civil Servants Study (426 individuals)[10]	DES prevalence at 53% using a validated questionnaire.	Contact lens wearers using computers for 6+ hours reported higher symptoms (65%) than non-wearers (50%).
Tear Film & Ocular Surface Society (TFOS) Dry Eye Workshop II Report[11]	Recommends standardized diagnostic protocols for DED, including symptom screening and clinical tests.	Suggested tools: OSDI, DEQ-5, non-invasive breakup time, osmolarity, ocular surface staining.

DRY EYE DISEASE

Dry eye, a condition of the tear film caused by insufficient or excessive tear evaporation, damages the interpalpebral ocular surface and is accompanied by a range of symptoms that indicate discomfort in the eyes and is characterized by homeostatic disturbances of the ocular surface and tear film[12,13] The Tear Film & Ocular Surface Society (TFOS) Dry Eye Workshop (DEWS) II defines DED as "a multifactorial disease of the ocular surface characterized by a loss of homeostasis of the tear film, and accompanied by ocular symptoms, in which tear film instability and hyperosmolarity, ocular surface inflammation and damage, and neurosensory abnormalities play etiological roles"[13]

DED is a serious and important public health concern that impacts around 344 million individuals and globally, the prevalence varies by location, ranging from 5% to 50%.[13] Among the most common reasons why people consult eye care professionals is DED.[14]

SYMPTOMS

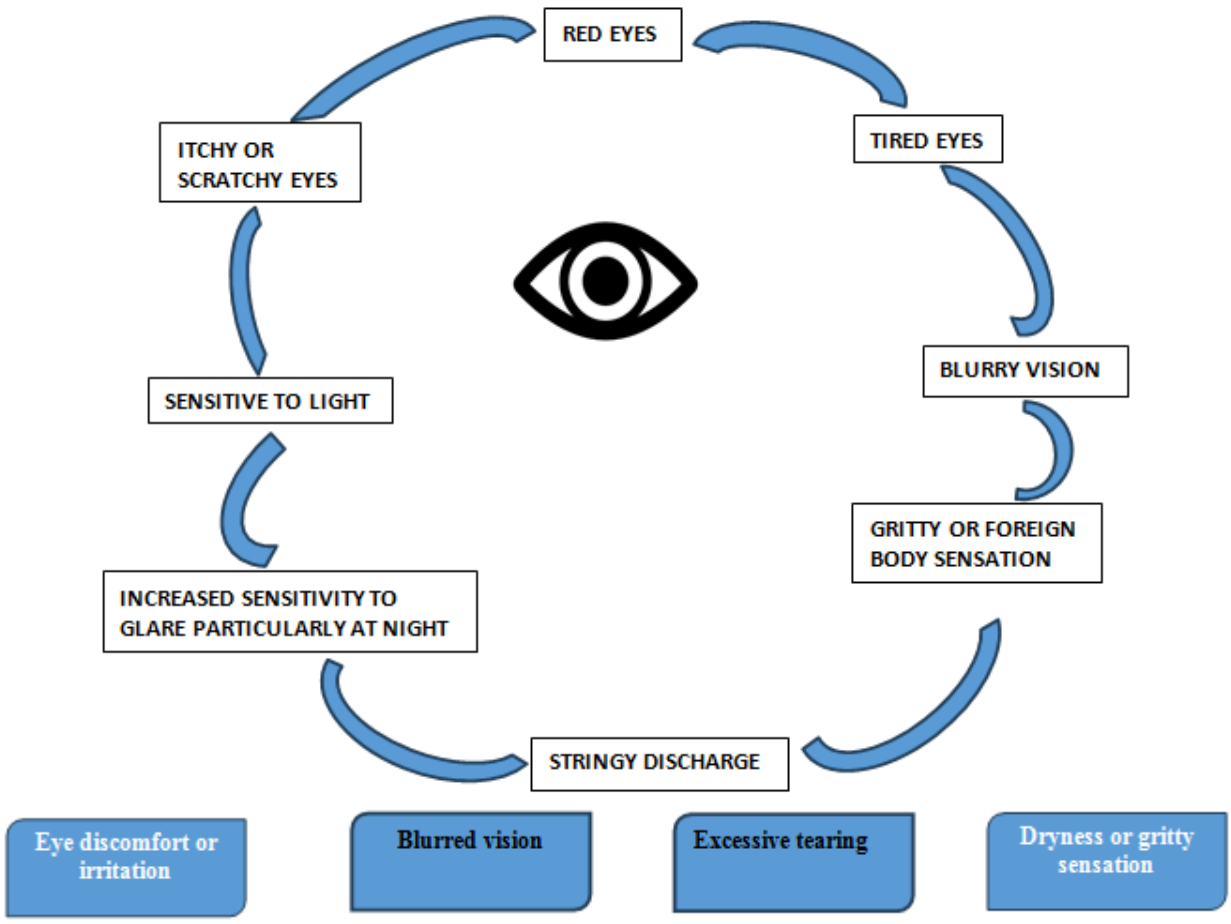


Figure 2: Common symptoms of Dry Eye Disease.

Multiple ocular surface diseases can arise from dry eye, a complex, heterogeneous condition of the preocular tear layer. Numerous disrupting influences might cause the complex and stable system that is the tear film and ocular surface to lose equilibrium.[15] The onset of dry eye symptoms will inevitably result in a decrease in quality of life. From mild, temporary irritation to chronic dryness, burning, itching, redness, discomfort, ocular fatigue, and visual impairment, these symptoms can vary widely.

DED may induce a variety of ocular symptoms, including erythema, xerosis, discomfort, pruritus, stinging, burning, irritation, pain, photophobia, and a sensation of a foreign body.[13, 14] (Figure 2)

Table 2: Studies on Dry Eye Disease Prevalence.

Population	Prevalence of Dry Eye Disease (DED)	Age Group	Key Findings
Caucasians[16-20]	4.3% (males only) to 12.8% (both sexes)	Mixed ages	Based on Women's Health Study criteria; older age and female sex as risk factors
	8.7% - 11.0%	Mixed ages	Prevalence of signs and symptoms of DED
	21.4%	Over 65	Higher prevalence in women and increases by age
East Asians	16.0% - 23.7%	Mixed ages	Based on Women's Health Study criteria [21-23]
	16.7% - 33.4%	Mixed ages	Higher rates of signs and symptoms of DED [24-28]
Singapore (Salisbury Eye Evaluation) [29]	8%	Mixed ages	Annual incidence rate of 5.1%
India [30]	26.2%	≥40 years	Higher than the global prevalence and ranges from 18.4% to 54.3% [31-32]
United States [18]	9.3%	≥18 years.	Prevalence increased with age (18–34 years: 2.7%; 75 years: 18.6%) and ≥ higher among women (8.8%) than men (4.5%)
Iran [33]	26.3%	Adults	Prevalence of meibomian gland dysfunction (MGD)
	71.2%	Over 60	MGD prevalence increases significantly in older age[34]

RELATIONSHIP BETWEEN DIGITAL EYE STRAIN AND DRY EYE DISEASE

The use of digital devices has increased dramatically over the last ten years, which raises the risk of DES. Several articles has shown significant relationship between digital eye strain and dry eye disease. DES reported lower health quality, slept less, spent more time indoors with air conditioning, consumed more caffeinated beverages, spent more time on computers, and scored higher on all questionnaires.[35]

Prior to the COVID-19 pandemic, there were reports of varying prevalence of DES symptoms ranging from 5% to 65%.[24,36,37] A study found that increased teleworking significantly worsened eye strain with 28.6% of subjects classified as having severe DED, especially among women.[37] 97.9% of students reported an enormous rise in dry eye and digital eyestrain with most common symptoms: headache85, neck pain and tearing.[39,40] Conjunctivitis, eye allergies, glares, weary eyes, neck pain, back pain, and daily screen time exceeding nine hours were all associated with a likelihood of developing DES and DED symptoms ($P < 0.05$ for all) where DED scores rise exponentially in tandem with an increase in DES scores.[41]

Post COVID-19 pandemic in a large study conducted in China, 81.6% of participants had DED, which is characterized by a tear breakup time (TBUT) of fewer than 10 seconds. Key risk factors include living in areas with severe weather, using cosmetics and contact lenses, aging (particularly over 60), and frequent exposure to digital screens. Up to 78.9% of individuals had unilateral DED underscoring the substantial public health burden and the necessity of early diagnosis and lifestyle modifications.[42] The impact of the COVID-19 pandemic on eye strain and dry eye symptoms, focusing on 388 participants the authors found that screen/reading time nearly doubled during pandemic, with 41% reporting decreased work efficiency, particularly those with moderate dry eye (51%, compared to 39% for mild and 38% for severe).[43] Participants with DES slept fewer hours, used computers longer ($P=0.010$), and had higher Dry eye scores on the OSDI (Ocular Surface Disease Index)($P<0.001$) and DEQ-5 (Dry Eye Questionnaire)($P<0.001$). Stress ($P=0.035$), contact lens use ($P=0.011$), migraines ($P=0.013$), and poor health quality were also significant risk factors.[44]

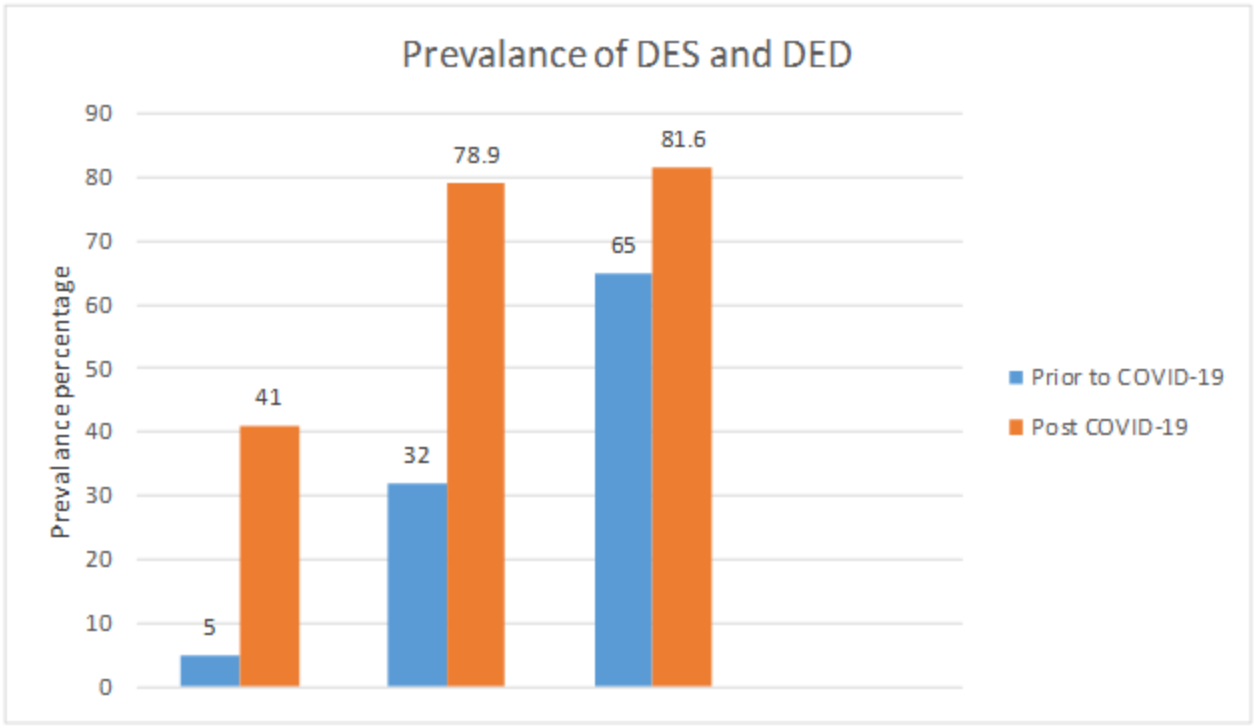


Figure 3: Prevalence of DES and DED - Prior and Post COVID-19.

PREVENTION OF DIGITAL SCREEN – INDUCED DRY EYE

Environmental changes as well as behavioural changes like blinking exercises or taking breaks from screens might help prevent or lessen dry eye in those who use digital screens.[45,46] Additionally, "blind working," a distinct tactic for avoiding dry eye from digital screens, was also assessed.[46] The suggested 20-20-20 rule (Figure 4) is a third effective technique to help avoid the symptoms of digital eye strain and dry eye. It is recommended that patients take a 20-second break and gaze at anything 20 feet away for every 20 minutes spent in front of a device.[47]

Figure 4 : The 20-20-20 Rule

Additionally, educating individuals with prolonged screen use to apply ergonomic workplace practices has improved visual symptoms and boosted productivity.[48]

Virtual reality headset use was found to produce a slight rise in ocular temperatures when compared to traditional desktop computer display use, but it was associated with clinically substantial improvements in lipid layer thickness and tear film stability. The study concluded that virtual reality headset wear demonstrates potential for dry eye relief for computer operators in the modern workplace environment.[49]

DIAGNOSIS AND MANAGEMENT OF DRY EYE DISEASE

Diagnostic tests are required to distinguish between dry eye, infections, and allergies, which can appear clinically identical but require separate treatments. The diagnostic tests classify patients into two treatment-based subgroups: "aqueous-deficient" and "hyper evaporative." The Dry Eye Workshop issued diagnostic guidelines in 2007.[50]

The recommended order for dry eye test is[50, 51] (Figure 5)

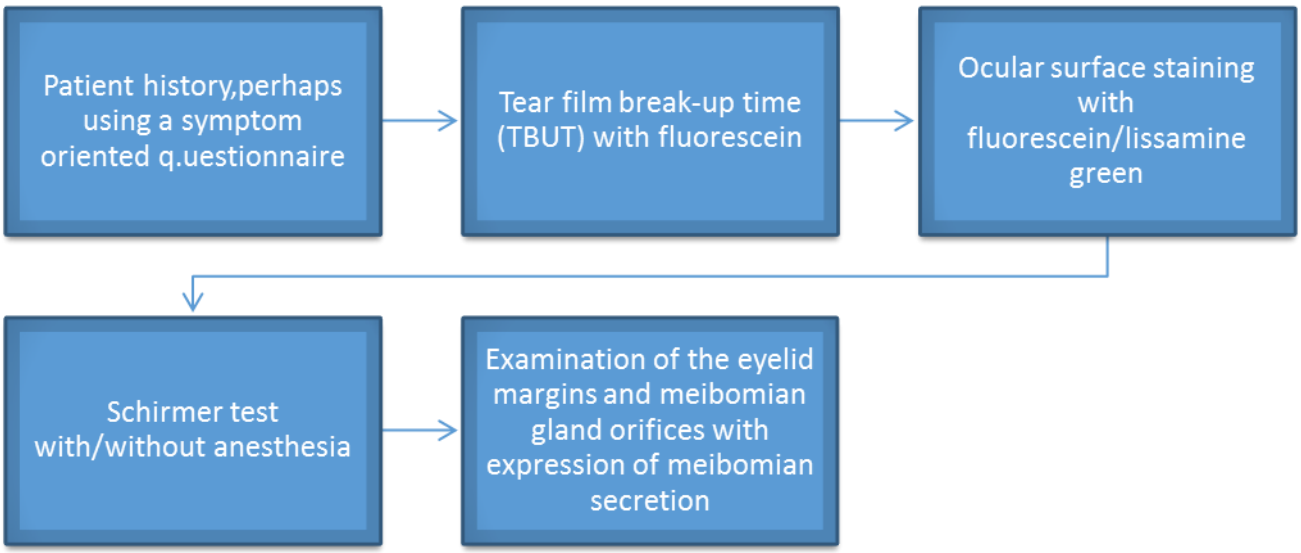


Figure 5: Recommended order for dry eye test.

According to Ohashi et al., clinical dry eye would be confirmed by a combination of dry eye symptoms, interesting results on the Schirmer (< 5 mm wetting after 5 minutes) and fluorescein clearance tests, and fluorescein and Rose Bengal staining (> 3+). Other authors have proposed various diagnostic criteria, and there is no agreement in this area.[52-55]

Numerous studies indicate that ergonomic measures may be essential in the treatment of digital eye strain. Commonly acknowledged ergonomic techniques include altering image characteristics, carefully setting up the digital devices, and using the right lighting.(text size, contrast, illumination, clarity), as well as taking intervals.[56-58] Many propose taking breaks as management strategy.[58-62]

Clinicians should thus clearly identify the underlying etiology, such as EDE or ADDE, which are the mechanisms that result in DED, and/or other ocular surface illnesses when diagnosing dry eye, and then provide the appropriate medications in accordance with that diagnosis.[63,64]

DED treatment aims to restore tear film balance and prevent recurrence.The Tear Film and Ocular Surface Society Dry Eye Workshop II (TFOS DEWS II) provides structured management and treatment recommendations for DED.[65] When treating dry eye at home in its early stages, patients can typically use low-risk, easily accessible over-the-counter lubricants; however, more advanced treatment alternatives should be taken into consideration for individuals who have progressed.[66-68]

CONCLUSION

Digital Eye Strain (DES) and Dry Eye Disease (DED) represent interconnected and increasingly significant global public health challenges, driven by the pervasive adoption of digital devices across all demographic groups. This narrative review underscores the complex relationship between DES and DED, highlighting shared etiological factors such as prolonged digital screen exposure, reduced blink rates, environmental conditions, and ergonomic deficiencies. The COVID-19 pandemic further intensified these issues, with a marked rise in screen time associated with teleworking, online education, and digital leisure activities, contributing to a notable increase in both DES and DED prevalence and symptom severity.

Preventative strategies, including structured blinking exercises, adherence to the 20-20-20 rule, ergonomic workplace adaptations, and environmental modifications such as humidification, offer promising avenues for mitigating the burden of DES and DED. Advanced diagnostic methodologies, encompassing clinical assessments and innovative imaging techniques, enable precise identification of disease subtypes and tailored therapeutic interventions. Comprehensive management strategies, such as those outlined by the Tear Film and Ocular Surface Society (TFOS DEWS II), advocate a tiered and individualized approach to addressing the multifactorial pathophysiology of these conditions.

'Vision 2020' Right to Sight is a global initiative by World Health Organization (WHO) and IAPB (International Agency for Prevention of Blindness)

launched in 1999 with a goal of eliminating avoidable blindness by year 2020.The National Programme for Control of Blindness (NPCB) was launched in 1976 as a 100% centrally sponsored scheme (now 60:40 in all states and 90:10 in NE States) with the goal of reducing the prevalence of blindness to 0.3% by 2020. The programme has been renamed in the year 2017 as National Programme for Control of Blindness and Visual Impairment (NPCB&VI). Rapid Survey on Avoidable Blindness conducted under NPCB during 2006-07 showed reduction in the prevalence of blindness from 1.1% (2001-02) to 1% (2006-07). the Primary Health Care team, led by a Community Health Officer (CHO) would ensure that regular eye screening is undertaken, coordinates with the Rashtriya Bal Swasthya Karyakram (RBSK) Team for screening children of age group 0-18 years in the Anganwadi and schools, manage the referral of those requiring surgery and treatment of refractive errors, ensure access to free spectacles, and would also undertake home and community based follow up visits.

Apart from cataract surgeries, now the focus of the programme is on treatment and management of other eye diseases like glaucoma, diabetic retinopathy, Vitreoretinal diseases, corneal blindness, low vision and childhood blindness. The programme is now geared to take care of all categories of visual impairment.

To further alleviate the substantial burden of DES and DED, future research should focus on exploring novel therapeutic modalities, evaluating the impact of emerging technologies such as virtual reality on ocular health, and promoting evidence-based guidelines for safe digital device usage. Addressing the intricate interplay between DES and DED necessitates a collaborative, multidisciplinary approach aimed at enhancing ocular surface homeostasis, improving diagnostic accuracy, and optimizing patient outcomes in an increasingly digitalized world.

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