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## Digital Eye Strain in the Digital Age: A Survey- Based Analysis

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### Abstract

**Purpose:** The primary goal of the survey study was to assess the prevalence, symptoms, and contributing factors of digital eye strain among various groups of population who use digital devices. Additionally, aimed to evaluate the effectiveness of various preventive measures to reduce the strain of eye caused by the use of digital devices.

**Background:** With the growing dependence on digital devices for work, education and entertainment digital eye strain [DES] has become a common ocular health problem. Even with increased awareness, the need for detailed information is still required to determine extent of the problem and the effectiveness of preventive measures among diverse population.

**Methods:** An online cross-sectional survey was undertaken with a diverse population of 403 participants over the course of eight months using digital devices. The questionnaire included sections on demographic data, device usage habits, signs and awareness of DES. Tools such as the Perceived Stress Scale (PSS-10) and the Computer Vision Symptom Scale (CVSS-17) were utilized.

**Results:** The survey results indicated that 68.9% of participants experienced increase in DES symptoms post-pandemic. Commonly reported symptoms included burning eyes in 16.8%, blurred vision in 13.5% participants and several other ocular problems. Notably, 33.9% of these participants are familiar with 20-20-20 rule.

**Keywords:** DES- Digital eye strain, demographic ocular health, pandemic

### Introduction

Digital eye strain is the ocular pain and visual irritation caused by the use of digital device which is an emerging public health concern <sup>[1]</sup>, has been acknowledged as a health issue for more than 20 years <sup>[2, 3]</sup>. It is the condition that arises from prolonged staring at digital screens on devices and is observed in people of all ages and has significantly increased the incidence of eye-related illnesses in both young and old people <sup>[4]</sup>. While there are many advantages to the rise of digital innovation, there are also new difficulties, like digital eye strain.

Innovative technology has transformed every aspect of our lives that includes healthcare and education. The 1980s saw the start of the third industrial revolution, popularly referred to as the digital revolution <sup>[5]</sup>. The use of various kinds of Information and Communication Technologies (ICT) <sup>[6]</sup>, in teaching provide distinctive training and educational opportunities that supports innovative and creative learning environments in educational institutions <sup>[7]</sup>. E-learning is playing a vital role in the existing educational setting, as it changes the entire education system and becomes one of the greatest preferred topics for academics <sup>[8]</sup>.

Compared to pre-pandemic period, internet usage increased from 40% to 100% <sup>[9]</sup>. The surge in digital screen time during the pandemic has been highlighted in the studies examining the effect of screen time on ocular health <sup>[10]</sup>. Due to the pandemic, there had been extensive restrictions on outdoor activities, despite the restrictions, people were able to accomplish their goals due to innovative technology, but an excessive dependence on digital devices has had a negative impact on people's physical and mental health <sup>[11]</sup>. People used different methods for work and entertainment which lead to increased amount of time spent indoors and using screens excessively <sup>[12, 13]</sup>. And by closure of workplaces, the number of people working from home had increased, leading to more screen time <sup>[14, 15]</sup>. And turning to alternative forms of entertainment at home and the inability to engage and socialize in person has also led to a rise in the use of other digital screens. Schools and colleges were completely closed and students had been provided with alternative resources that is available online <sup>[16]</sup>. 94% of students worldwide were impacted by the closure of educational institutions <sup>[17]</sup>.

Studies on online learning and visual impacts showed that visual problems and various musculoskeletal problems, are known as digital eye strain (DES) [18]. In Oman, a study that examined on stress levels among college students by the impact of COVID-19-induced e-learning. Out of 966 participants, 96.9% reported experiencing stress ranging from moderate to high levels. The study found that student academic achievement was negatively affected by stress [19]. By extended use of digital devices prior to COVID-19, reports of variable prevalence ranging from 5 to 65% have been made [20]. According to survey responses on Digital Eye Strain report from US adults in the 2016, the overall prevalence of symptoms was 65%, with females more commonly affected than males that is 69% vs 60% prevalence [21].

Three potential pathways that could contribute to the symptoms associated with DES include the extraocular mechanism, the accommodative mechanism, and the ocular surface mechanism [22]. Shoulder pain, headaches, backaches and stiff necks are examples of musculoskeletal symptoms linked to postural problems that can result from extraocular mechanisms unrelated to direct eye use, [23] these issues often result from an inappropriate distance between the eyes and the screen or from the incorrect placement of the computer screen, leading to unnecessary forward bending or stretching, which strains the muscles [24, 25]. The second pathway involves accommodative mechanisms, which may cause myopia, presbyopia, double vision, blurry vision and a gradual difficulty in shifting focus, [26, 27] These changes are not due to the screen itself, but rather the prolonged use of digital devices that lead to accommodative stress [28]. The third pathway, the ocular surface mechanism, is associated with symptoms such as dry eyes, redness, blurred vision, and burning sensation due to prolonged use of computer. Normally, Eyeblick aids in preserving a healthy ocular surface and prolonged exposure to digital devices, blink rate reduces dramatically [29]. Squinting and reduced blinking are associated with various pathophysiological mechanisms. Initially, squinting improves vision in cases of refractive errors and reduces retinal brightness when exposed to a bright light source, sustained squinting and reduced blinking contribute to ocular discomfort [27].

Common signs and symptoms of Digital Eye Strain include headaches, dry eyes, blurred vision, eyestrain, and shoulder and neck pain [30]. The term Asthenopia is used for eyestrain, which can be classified as internal and external symptoms. Internal symptoms, such as strain behind the eyes are associated with accommodative and binocular vision stress [24]. External symptoms, on the other end, include burning, irritation, tearing, and dryness [31, 32], the broadened symptoms of DES is exotropia and vergence abnormalities as DES spectrum increased progression of existing myopia is the critical ocular health complications [21]. beyond ocular complications, there is evidence that more screen time has to poorer diet, cognitive performance, impaired interpersonal relationships, and overall quality of life [27]. According to numerous studies there are various factors such as uncorrected refractive error, accommodative and vergence anomalies, altered blinking patterns, prolonged exposure to bright light, closer working distances and smaller font sizes, [1] using liquid crystal display (LCD) screens for e-readers as opposed to reading from paper copies or e-ink displays are all linked to digital eye strain [33]. Many studies shows that computer use significantly reduces blink rate, which may exacerbate dry eye symptoms, [34] Higher squint levels further decrease blink

frequency, contributing to discomfort [32]. Factors such as altered blink patterns, ambient environmental conditions, and gaze angle can accelerate tear film evaporation, increasing the risk of dry eye [35, 36] It has been demonstrated that using lubricating eye drops alleviate these symptoms [37]. In terms of preventive strategies, recommended working distances for computer monitors are approximately 500 mm are [38] with minimum viewing distances of 500–635 mm [39, 40] Further management for DES is by monitoring screen time allows individuals to minimize time spent on screen [21]. Additionally, use of glasses with antireflective coating and correction of refractive errors [5, 41]. Along with these use of ergonomic chairs, improvement in lighting, minimizing glare must be made and motivate to follow the 20-20-20 rule, that states taking a 20-second break every 20minutes by focusing on an object 20 feet away [42]. Collectively, These interventions minimize the ocular strain associated with prolonged digital screen exposure.

## Materials and Methods

### Design and variables

A quantitative cross-sectional web-based survey study was used to evaluate the impact of the independent variable such as online learning, remote work on the dependent variable, that are eye strain, healthier life style, physical and mental stress.

**Population** This study is aimed to analyze students, working professionals, home maker on the impact of the digital eye strain.

The total population consisted of W=403

### Sample size and technique

The sample size was determined using the Rao-soft sample calculator, [43] from the population size of 403 at an error rate of 5%, confidence intervals of 95%, and response rate of 50%.

### Research tool

Three self-reported instruments were used in the study that are the Perceived Stress Scale (PSS-10), Computer-Vision Symptom Scale (CVSS-17), has a rating scale, with 17 questions designed to evaluate 15 distinct eye symptoms Socio-demographic Data Sheet (SDDS), which contained 12 categorical variables

### Ethical Considerations

An invitation was sent to the target population through Google Forms to obtain written consent. An email containing a Google link was dispatched to the participants' email addresses, which outlined the study's objectives, the option to withdraw and guaranteed confidentiality.

### Data Collection Procedure

The data was collected using the web-based self-reported method. A Google form was constructed and link was circulated to the targeted population through their email id. The response of the 403 participants was received and analyzed.

### Data Analysis

The data was calculated in percentage for obtained frequency and statistically analyzed in the pie chart.

### Data Protection

The entirety of the gathered data underwent encryption

measures and was subsequently stored in an electronic format safeguarded by password protection. Sole access to the data was granted to the primary researchers exclusively for research endeavors. Moreover, a strict protocol was implemented to ensure the deletion of the data file after a period of five years, thus upholding the confidentiality of the participants. This meticulous procedure was devised to uphold ethical standards and uphold the privacy rights of all involved participants.

### Limitation to methodology

The sample size proved inadequate relative to the size of the population. Collecting data online, as opposed to in person, resulted in a lack of inherent motivation among participants, thereby diminishing their response rate in the study.

### Results

The rise of digital innovation is growing dependence on the digital devices and brought about an increase in digital eye strain among various demographic people. E-learning is revolutionizing the entire education system and becoming a highly favored method of education. Thus, it increases eye strain among students. However, the COVID-19 pandemic necessitated to shift to remote learning, working from home and for alternative indoor entertainments, this prolonged exposure of eyes to blue light and these changes resulted in a lack of visual stimulation and increased in DES.

The survey collected responses from 403 diverse

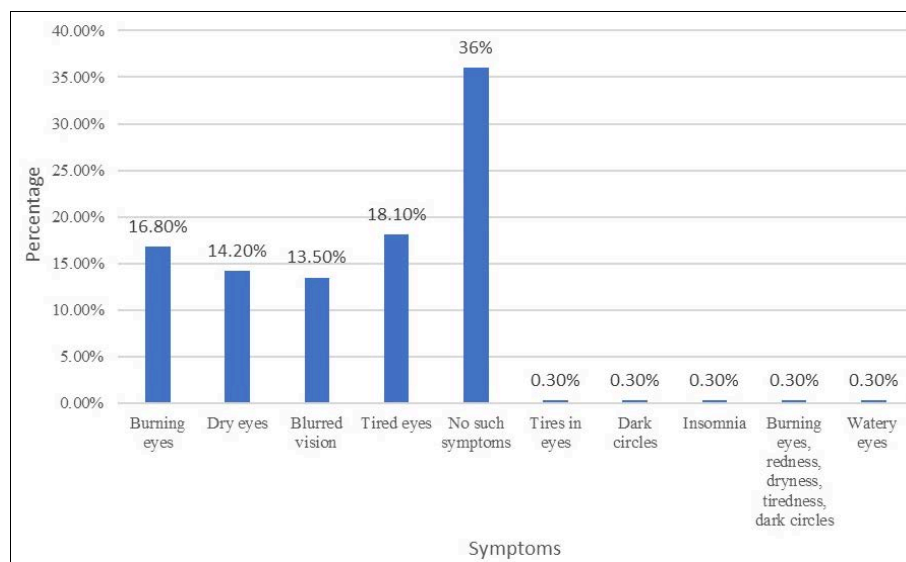
demographic profile participants in terms of age, gender, occupation. Females made up 57.5% and males 42.5% of the participants aged 15-35 years were part of survey. Majority of them were aware about DES that is 68.1%. And by the survey study it was reported that DES is not affected by gender. Post-pandemic 51.3% preferred studying through gadgets as handsets are assumed to be affordable and easy to use anywhere for the students as passive listeners to the online lectures, among them 73.6% children under 13 were assumed to be affected by DES. 92.5% agrees that there should be public education about the lasting effects of excessive screen time and encouraging healthier life style practices.

- 1. Ocular complaints:** 75.9% are aware of DES symptoms, participants indicate some symptoms related to DES that are 16.8% with burning eyes, 14.2% dry eyes, 13.5% blurred vision, 18.1% tired eyes, 0.3% with dark circles, insomnia, watery eyes and combination of all these symptoms and 36% have no symptoms related to DES.
- 2. Awareness:** Subsequent finding 63% of survey participants believe adequate sleep, 46.9% has opinion that blinking eyes and 49.7% likely use of blue light filtering glasses can reduce the DES. Among these participants 46.1% are aware of self-care remedies for DES. 68.7% takes breaks while using digital devices and only 33.9% are familiar with the 20-20-20 rule.

**Table 1:** Socio-demographic variables of participants illustrated using frequency and percentage

Social-demographic variables		Frequency	Percentage
Gender	Male	164	42.5%
	Female	222	57.5%
	Total	386	95.7%
Age group	Below 15	12	3.1%
	15-25	288	74.6%
	25-35	61	15.8%
	35 and above	25	6.5%
	Total	386	95.7%
Occupation	Studying	268	69.4%
	Working	95	24.6%
	Home maker	21	5.4%
	Unemployed	1	0.3%
	Business	1	0.3%
Aware of DES (Digital Eye Strain)	Yes	263	68.1%
	No	72	18.7%
	May be	51	13.2%
Pandemic affected an increase in DES	Yes	266	68.9%
	No	44	11.4%
	May be	76	19.7%
Decrease in outdoor activities increases screen time	Yes	298	77.2%
	No	45	11.7%
	May be	43	11.1%
Online education and working from home are the risk factor for DES	Yes	256	66.3%
	No	33	8.5%
	May be	86	22.3%
	Do not know	11	2.8%
Prefer using mobile devices at night	Yes	173	44.8%
	No	213	55.2%
Symptoms related to DES (Digital Eye Strain)	Burning eyes	65	16.8%
	Dry eyes	55	14.2%
	Blurred vision	52	13.5%
	Tired eyes	70	18.1%
	No such symptoms	139	36%
	Tires in eyes	1	0.3%
	Dark circles	1	0.3%
	Insomnia	1	0.3%
	Burning eyes, redness, dryness, tiredness, dark circles	1	0.3%
	Watery eyes	1	0.3%

Adequate sleep reduces the risk of DES	Yes	243	63%
	No	37	9.6%
	May be	106	27.5%
Familiar with the 20-20-20 rule	Yes	131	33.9%
	No	159	41.2%
	May be	96	24.9%
DES can be reduced by blue light filtering glasses	Yes	192	49.7%
	No	72	18.7%
	May be	122	31.6%
How often eyes examined by an ophthalmologist	Yearly once	170	44%
	6 months once	76	19.7%
	3 months once	19	4.9%
	Never	121	31.3%
Should be public education about the lasting effect of excessive screen time and encouraging healthier life style practices	Yes	357	92.5%
	No	29	7.5%
Aware about self-care remedies for DES	Yes	178	46.1%
	No	137	35.5%
	May be	71	18.4%
Personalize screen time	Yes	222	57.5%
	No	82	21.2%
	May be	82	21.2%



**Fig 1:** Symptoms related to DES among participants

## Discussion

The survey's findings present a comprehensive overview of the common digital eye strain and its impact on users. A significant proportion of participants reported experiencing symptoms such as burning eyes, dryness, blurred vision, tired eyes, dark circle, insomnia and watery eyes. The survey also identified key contributing factors for DES, including prolonged screen time by the transition to remote work and learning during the pandemic.

The survey also provided valuable insights into the effectiveness of various preventive measures. Participants who adhered to the 20-20-20 rule and used blue light filters reported fewer and less severe symptoms of digital eye strain.

However, despite the widespread awareness of digital eye strain, the implementation of preventive measures remains inconsistent. This indicates a gap between knowledge and practice, suggesting that more robust educational campaigns and workplace policies are needed to promote eye health among digital device users.

## Conclusion

The results of this survey focus on the impact of use of digital devices on ocular health. The findings highlight the critical need for increased awareness and consistent

implementation for preventive measures to mitigate the adverse effects of prolonged screen time. The results of this survey provide a foundation for future research aimed at developing more effective strategies and guidelines for managing digital eye strain. Additionally, they emphasize the importance of ocular health in an increasing dominance of digital world. By addressing the identified gaps between awareness and practice, healthcare professionals, educators play a pivotal role in reducing the burden of digital eye strain and enhancing the overall well-being of digital device users.

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