

# The Impact of Digital Screen Exposure on Visual Health Among University Students A Cross-Sectional Study

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## Abstract

**Background:** Today, many higher education students are exposed to digital devices on a daily basis, which has led to a significant increase in the exposure to screens, and the negative effects on visual health are a concern. Digital Eye Strain (DES) occurs when you have prolonged exposure to digital screens, and can result in symptoms such as eye fatigue, dry eye, blurred vision, headaches and difficulty focusing.

**Objective:** This study aims to assess the effect of Digital Screen Use on visual health and to find factors associated with Digital Eye Strain among university students in Saudi Arabia. **Methods:** This study was a cross-sectional analysis study, using a structured self-administered questionnaire with 200 students at the University in Saudi Arabia. The data obtained included the sociodemographic data, time spent at electronic screens, ergonomic habits, and visual health symptoms. Chi-square and One-Way Analysis of Variance (ANOVA) used to analyze the data.

**Findings:** The findings showed that there was a significant relationship between prolonged daily screen use and Digital Eye Strain ( $\chi^2 = 24.83$ ,  $p < 0.001$ ;  $F = 32.81$ ,  $p < 0.001$ ). Significant associations were also observed between Digital Eye Strain and viewing distance ( $\chi^2 = 22.94$ ,  $p < 0.001$ ), adherence to the 20-20-20 rule ( $\chi^2 = 12.55$ ,  $p < 0.001$ ), screen brightness ( $\chi^2 = 7.52$ ,  $p = 0.006$ ), frequency of taking breaks ( $\chi^2 = 6.03$ ,  $p = 0.014$ ), gender ( $\chi^2 = 5.74$ ,  $p = 0.017$ ), and blue-light filter use ( $\chi^2 = 4.03$ ,  $p = 0.045$ ). The One-Way ANOVA also found significant differences between the prolonged uninterrupted screen use, sleep duration, multiple digital devices and year of study groups in their mean scores of D.ES ( $p < 0.05$ ).

**Conclusion:** There is a significant link between the use of digital screens and visual health in university students in Saudi Arabia. Digital eye strain is caused by prolonged screen use, and ergonomic problems. Encouraging positive screen use habits, good ergonomic practices and visual rest breaks can help minimize eye discomfort and enhance the ocular health and learning outcomes of students.

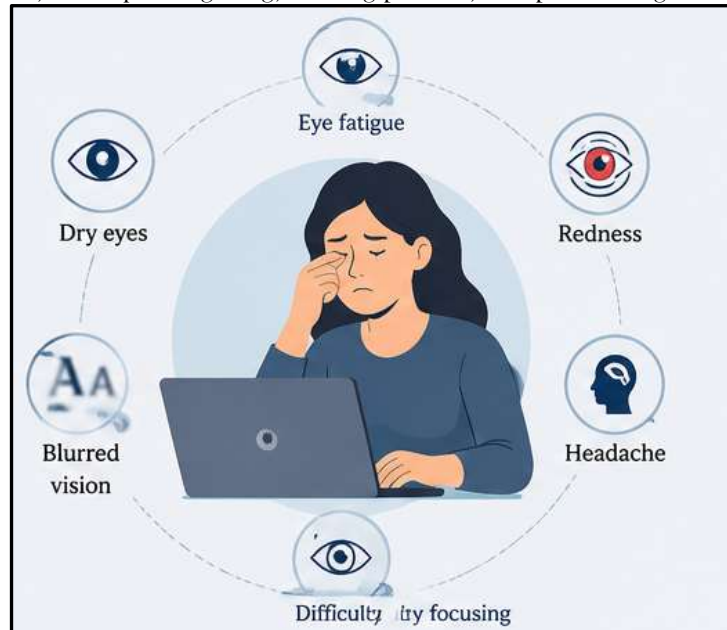
**Keyword:** Digital Eye Strain, Computer Vision Syndrome, Digital Screen Exposure, Visual Health, University Students, Saudi Arabia, Screen Time and Ergonomics.

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## INTRODUCTION

Digital technology has revolutionized the world of education with the rapid growth of digital devices including smartphones, laptops, tablets and desktop computers becoming essential for learning, communicating and entertaining in the classroom. One of the main groups of people using such devices are students from across the universities in the world, they invest a lot of time in taking lectures online, searching for information, doing the homework, interacting with their peers in social networks, using multimedia. Digital technologies have improved educational accessibility and efficiency but long-term exposure to digital screens has led to increasing concerns about the potential effects of digital screens on visual health.[2, 5, 6]Digital screen exposure exposure has been linked with various eye and visual complaints that are grouped together under the term of Digital Eye Strain (DES) or Computer Vision Syndrome (CVS). Symptoms of Digital Eye Strain include eye weariness, unclear vision, dry eyes, burning sensation, redness, headaches, too much tearing, light sensitivity, and struggles to focus with screens for an extended period of time.[8] this situation may occur due to various reasons, such as reduced blink rate, prolonged accommodative effort, glare, inappropriate viewing distance, poor ergonomics and extended uninterrupted screen time. Excessive exposure to digital devices can also lead to musculoskeletal issues like neck, shoulder and upper back pain, impacting students' overall well-being and their output as students. [1, 9]

Since the start of the COVID-19 pandemic, the use of digital technology has escalated even further, with the majority of schools having switched to virtual classrooms with the outbreak of the pandemic. Although a large portion of the educational process has returned to the classroom, the use of learning platforms and digital tools has also been a major component in higher education. University students are thus still subject to prolonged screens use and visual health is an important public health issue. Some international studies have found high incidence of DYS among university students ranging from 50% to over 90% depending on the assessment method and study group [11, 13]. It is consistently found that factors associated with visual discomfort include the use of screens for more than 4-6 hours per day, no breaks from the screen, inadequate lighting, viewing posture, and pre-existing refractive errors.



**Figure 1:** Common Symptoms of Digital Eye Strain

In KSA, the application of digi-tech has increased to a substantial level, as this is one of the major components of Saudi Vision 2030 which focuses on digital transformation and technology-enhanced learning.[15] Devices running on digital technologies are widely used by students across the universities in KSA for educational, professional and personal use, which may make them vulnerable to visual/ocular health issues. Although digital devices are widely used among all populations, data on the extent of visual health issues related to digital screens in Saudi university students is limited and studies generally report on a single university or academic field. Furthermore, there are significant differences in digital device usage patterns, the usage scenario and the practices followed for eye care may require a detailed research in a wide range of student populations.[3, 4]

Research on the relationship between digital screen exposure and visual health is essential to develop evidence-based strategies to try to reduce visual discomfort and promote digital screen use among University students. Knowledge of potentially modifiable factors could help to facilitate effective targeted educational interventions and institutional health promotion initiatives, such as excessive screen time, inadequate rest breaks, poor posture and screen positioning, etc.

Therefore, the aim of the present cross sectional study is to evaluate the association between digital screen exposure and visual health among university students in Saudi Arabia, and to add to the existing literature on digital eye health in university settings to support the implementation of preventive measures and improve the health of the university students.

### **Rationale and Need for the Study**

Heavy use of the electronic screens can result in Digital Eye Strain (DES) or Computer Vision Syndrome (CVS), which include eye fatigue, dry eyes, blurred vision, headaches, eye burning, eye redness, difficulty concentrating, reduced productivity and reduced quality of life for students. The use of digital technology is growing, but there is limited and insufficient evidence of the prevalence of digital eye strain among

university students in Saudi Arabia and the factors that might contribute to this. Conclusions of previous studies are not always easy to generalize because they may come from singular institutions or samples of small size or from a particular student population.[8] A cross sectional study is needed to evaluate the relationship between digital screen exposure and visual health of university students in Saudi Arabia, designed in an appropriate way. Healthcare providers, university administrators, and policy makers will need to have a basic understanding of the proportion of the population that experiences any of the visual symptoms and the behavioral, environmental and demographic factors associated with digital eye strain to use as evidence.

## REVIEW OF LITERATURE

The excessive screen time is a problem that university students in the world are confronting due to the use of digital devices for their education, communication and entertainment. With this trend, there is increasing awareness of the Digital Eye Strain (DES) also known as Computer Vision Syndrome (CVS) which involves a collection of eye and visual symptoms that stem from the use of digital screens for extended periods of time.[1, 4] Symptoms include eye fatigue, dryness, blurred vision, headaches, burning sensation, redness, diplopia, and problems focusing. The symptoms are associated with the reduction in the blink rate, and increase in the accommodative effort, glare and the lack of ergonomics, viewing distance and longer periods of continuous screen viewing. [7] Results of a 2023 systematic review and meta-analysis of over 100 cross sectional studies of more than 66,000 subjects indicated a general prevalence rate of Computer Vision Syndrome of about 69%. [4, 8] High prevalence was especially observed among university students (76.1%), females, contact lens wearers and those who spend more than 10 hours in a day in front of screens. The review confirmed that digital eye strain is a serious global public health issue and that there is a need to focus on digital eye strain prevention and further digital eye strain related epidemiological research. [12, 13]

A good number of researchers have conducted studies to find the most appropriate symptoms of digital eye strain is extended daily screen time.[13, 14] Pupils who use digital devices for over four to six hours a day are much more likely to have blurred vision, dry eyes, headaches, and musculoskeletal discomfort. Poor sitting posture, insufficient ambient light, too close to the screen, not taking breaks often enough, positioning the screen too close or too high, and refractive errors are other common reported risk factors. The 20-20-20 rule, proper ergonomics and blinking have been recommended to reduce the exertion on eyes. [15, 16]

The digital transformation of the Higher Education sector has seen a significant increase in students' dependence on electronic devices over the last few years, with the widespread adoption of e-learning platforms in Saudi Arabia. [8, 10] There are several Saudi studies that have found a very high prevalence of Computer Vision Syndrome in university students. A study of the health science university students revealed that the majority of the students reported one or more symptoms associated with digital eye strain with eye fatigue, headache, dry eyes and blurred vision being the most commonly reported complaints. [13] Important risk factors found were extended screen time, female sex, continuous use of the device for a long time, poor working posture and lack of knowledge about the importance of screen hygiene.[7, 8, 9]A recent Saudi cross-sectional study also revealed that Computer Vision Syndrome is a very common condition among university students, and that severe visual symptoms were present as a direct consequence of the increase in the amount of time spent viewing screens. Differences were also found between subjects, with students in subjects with high digital learning demands appearing to be more vulnerable to developing visual discomfort.[11, 12]

This is confirmed by other data for neighbouring countries in the Middle East. A recent study in Oman conducted in the University students revealed that there is a high prevalence of Computer Vision Syndrome and also a significant association was found between the uncomfortable seating posture, short viewing distance, prolonged recreational screen time and poor ergonomic behaviours. [15, 16] Similarly, studies among health science students revealed blurred vision, photophobia, eye dryness, headaches, and problems with focus as the most prevalent symptoms, and many reported substandard ergonomics when using devices.[18]

While there have been previous studies that confirm the prevalence of digital eye strain, there are still key areas that require further knowledge. Most of the investigations have been conducted at individual

universities, within certain disciplines (e.g., medicine or health sciences) or on relatively small sets of respondents, making the scope of generalizability of their results restricted. Thus, a multicenter cross sectional study to evaluate the digital screen exposure and visual health of university students is justified. This evidence will assist in pinpointing changeable risk factors and guide the creation of evidence-based interventions, ergonomic guidelines and health promotion strategies to keep students' visual health protected while still enjoying the advantages of digital learning.

### **Research Gap**

A number of studies have been conducted on Digital Eye Strain (DES) and Computer Vision Syndrome (CVS) in university students around the world and there are still some important research gaps. Existing studies are largely carried out in one institution and/or in students from certain academic fields (e.g. medicine or health sciences), which restrict their applicability to the entire university student body. Limited studies exist in Saudi Arabia, and when conducted, they typically only aim to estimate the prevalence of visual symptoms without a comprehensive assessment of the relationship between the pattern of digital screen use, behavioral factors, ergonomic habits, and visual health outcomes. In addition, the effect of screen time, digital devices types, distance of screen, lighting conditions, and preventing eye care practices on visual health among university students in Saudi Arabia are not evaluated. Hence, a well-designed cross-sectional study among university students in Saudi Arabia is needed to assess the relationship of digital screen exposure to visual health. The results of the present investigation can contribute to close these gaps in knowledge by providing up-to-date evidence of the prevalence of digital eye strain, identifying modifiable risk factors, and developing evidence for targeted health promotion strategies, ergonomic interventions and institutional policies that can enhance visual health and minimize the burden of digital screen-related eye problems among university students.

### **Study Objective**

To evaluate the effects of digital screen exposure on visual health of university students in Saudi Arabia.

#### **Allied Objectives**

- Identify the rates and prevalence of digital eye strain and other visual health issues in University students in Saudi Arabia.
- To measure digital screen exposure, such as length of time spent on digital screens, type of digital devices, and reasons for device usage.
- To assess the relationships between digital screen exposure and visual health symptoms (eye fatigue, dry eyes, blurred vision, headaches, burning sensation, redness, watering, trouble focusing).

## **MATERIALS AND METHODS**

### **Study Question**

Some of the related study questions are as follows:

- Q1. What is the prevalence of digital eye strain and other visual health problems among university students in Saudi Arabia?
- Q2. How do university students use digital screens, including the amount of screen time per day, which digital devices they use, and for what purpose?
- Q3. Do digital screen exposure and visual health outcomes have a significant association for university students?

### **Study Design**

This present study uses the cross sectional study design, which is used to examine the association between digital screen exposure and visual health among university students in KSA. This cross-sectional design is suitable for determining the occurrence of visual health issues and determining factors that influence digital screen exposure at one time.

### **Study Setting**

This study will be carried out with students from public and private universities in Saudi Arabia. A structured online questionnaire will be disseminated via the universities' communication channels and social media and data will be collected.

### **Study Population**

The target population will be undergraduate and postgraduate students in the age range of 18 years or over, enrolled in recognized universities in Saudi Arabia and who are regular users of digital devices for academic and/or personal ends.

### Criteria of Inclusion and Exclusion

#### Inclusion

- Students studying at a university in Saudi Arabia, Bachelor or Master's degree.
- 18 years or older.
- Uses one or more digital devices (e.g., smartphone, laptop, tablet, or desktop computer) for 1+ hours per day.
- To be willing to engage and to give informed electronic consent.

#### Exclusion

- Students who have had surgery in the eye within the last six months.
- Patients with severe eye disease (such as glaucoma, retinal disorder, corneal diseases etc.) that is not related to digital screen exposure.
- Students who have neurological disorders that impact vision.
- The participants who do not complete their questionnaires or give inconsistent answers.

#### Sample Size

Cochran's formula will be used to determine the sample size for estimating a proportion with a 95% confidence level and 5% margin of error. For the greatest number of subjects, assume a prevalence of 50%, run a minimum sample size of 213 subjects. Approximately 200 students will be recruited in order to increase statistical power and to take into consideration the fact that not all students will complete the measurements.

#### Sampling Technique

Multistage stratified sampling technique will be used. First the universities will be chosen from various geographic areas in Saudi Arabia. In the selected universities the students will be segmented based on academic department/academic discipline and academic position. Eligible students will subsequently be invited to join the study using convenience sampling methods in the form of official social media and student associations and also via institutional email lists. This method is designed to get a sample of the University students that is as varied and representative as possible.

#### Study Variables

Dependent Variable	Independent Variables
Eye fatigue Dry eyes Blurred vision Burning sensation Eye redness Excessive tearing Headache Double vision Difficulty focusing Neck and shoulder pain.	Information from the screen (hours/day) Type of digital device used How many digital devices the student uses.

#### Data Collection

A detailed and structured questionnaire was prepared to collect information from the respondents. This questionnaire includes the following sections:

Part A: Sociodemographic characteristics.

Part 2: Digital screen exposure patterns.

A questionnaire will be made in English and Arabic to make it easier for the people to participate.

#### Validity and Reliability

The questionnaire will be based on the validated questionnaire like Ocular Surface Disease Index (OSDI) and Computer Vision Syndrome Questionnaire (CVS-Q). Content validity will be assessed by experts in the fields of optometry, ophthalmology and public health. A preliminary trial with about 30 students will

take place to test for clarity and feasibility. Alpha coefficients (0.70 or higher) will be used to check the internal consistency.

### Data Collection Procedure

An online questionnaire will be developed using a secure survey web site. The University's email system and student associations and official social media groups will be used to distribute the survey link. An electronic informed consent form will be provided to participants, detailing the purpose of the study, confidentiality policies, voluntary participation, and the amount of time that will be spent in the study. Only participants who agree to be part of the survey will be asked to fill out the survey. All answers will be anonymous.

### Data Management and Analysis.

The information collected will be analysed by IBM SPSS Statistics version 27 (or any other statistical software package). Bivariate analysis will be performed by Chi-square test and one-way ANOVA based on the type of variable. Relationships between screen time and visual symptom scores will be explored by using correlation analyses (Pearson or Spearman). Any factors that might be considered a confounder will be included in the multivariable logistic regression to identify independent factors for the development of Digital Eye Strain and poor visual health. Odds ratios (ORs) will be reported as adjusted odds ratios (AOR) with 95% confidence intervals (CI). Statistically significant will be accepted when p-value < 0.05.

### Ethical Considerations

Ethical clearance will be secured from the Institutional Review Board (IRB) and/or Research Ethics Committee (REC) of the institution(s) in which the data are to be collected before data collection is undertaken. The participation will be voluntary and the informed consent will be obtained electronically before filling out the questionnaire. There will be no collecting of any personally identifiable information and all responses will be kept confidential. The participant should have the right to drop out of the study anytime and for any reason without losing anything. All the gathered information will be stored securely and only used for research purposes following the ethical guidelines and data protection regulations.

### Data Analysis and Interpretation

#### Statistical Inferences

**Table 1:** Summary of Chi-Square Analysis

S. No.	Variable	Categories Compared	$\chi^2$ Value	p-value	Statistical Significance	Interpretation
1	Daily Screen Time	≤4 hrs, 5-8 hrs, >8 hrs	24.83	<0.001	Significant	Longer daily screen time was significantly associated with Digital Eye Strain.
2	Gender	Male vs Female	5.74	0.017	Significant	Female students had a higher prevalence of Digital Eye Strain.
3	Following the 20-20-20 Rule	Yes vs No	12.55	<0.001	Significant	Students not following the 20-20-20 rule experienced more Digital Eye Strain.
4	Screen Brightness	Low/Medium vs High	7.52	0.006	Significant	High screen brightness was associated with dry eye symptoms.
5	Viewing Distance	<40 cm vs ≥40 cm	22.94	<0.001	Significant	Short viewing distance was significantly associated with blurred vision.
6	Frequency of Taking Breaks	≤30 min vs >30 min	6.03	0.014	Significant	Less frequent breaks were associated with greater eye fatigue.

7	Blue-Light Filter Use	Yes vs No	4.03	0.045	Significant	Students not using blue-light filters reported headaches more frequently.
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### Interpretation

Statistically significant associations were found between digital screen exposure-related factors and visual health outcomes among university students through the use of the Chi-square analysis (Table X). The strongest association with Digital Eye Strain was with daily screen time ( $\chi^2 = 24.83$ ,  $p < 0.001$ ) showing that students exposed for a longer period a day were more likely to experience visual discomfort. An association was also noted between viewing distance and blurred vision ( $\chi^2 = 22.94$ ;  $p < 0.001$ ), with the potential for blurred vision to increase with a viewing distance of less than 40 cm. Likewise, 20-20-20 rule was significantly related to Digital Eye Strain ( $\chi^2 = 12.55$ ,  $p < 0.001$ ), with the group who did not follow the 20-20-20 rule having more symptoms. Dry Eye symptoms were also significantly associated with screen brightness ( $\chi^2 = 7.52$ ,  $p = 0.006$ ), taking breaks between screen sessions and eye fatigue ( $\chi^2 = 6.03$ ,  $p = 0.014$ ), digital eye strain and gender ( $\chi^2 = 5.74$ ,  $p = 0.017$ ), and headaches and blue-light filter ( $\chi^2 = 4.03$ ,  $p = 0.045$ ). In general, the results of this study showed that prolonged screen exposure and the use of inappropriate ergonomic positions are significantly related to Digital Eye Strain and its associated visual health issues among university students in Saudi Arabia.

**Table 2:** Summary of One-Way ANOVA

S. No.	Variable	Groups Compared	F-value	p-value	Statistical Significance	Interpretation
1	Daily Screen Time	≤4 hrs, 5-8 hrs, >8 hrs	32.81	<0.001	Significant	Mean Digital Eye Strain scores increased significantly with longer daily screen time.
2	Academic Year	First, Second, Third, Fourth Year & Above	6.48	0.001	Significant	Senior students had significantly higher mean Digital Eye Strain scores than junior students.
3	Average Continuous Screen Use	<1 hr, 1-2 hrs, >2 hrs	18.92	<0.001	Significant	Longer uninterrupted screen use was associated with higher Digital Eye Strain scores.
4	Number of Digital Devices Used Daily	One, Two, Three or More	11.27	<0.001	Significant	Students using multiple digital devices had significantly higher Digital Eye Strain scores.
5	Daily Sleep Duration	≥8 hrs, 6-7 hrs, <6 hrs	15.16	<0.001	Significant	Students with shorter sleep duration reported significantly higher Digital Eye Strain scores.

### Interpretation

The One-Way ANOVA analysis showed the mean Digital Eye Strain (DES) scores for each of the variables selected in the study were significantly different (Table 2). Correlation between daily use of electronic devices and the symptoms indicated that, in terms of association with the symptoms, the students who had longer time of daily use of electronic devices had higher mean scores than the students who had shorter time, in digital eye strain ( $F=32.81$ ,  $p<0.001$ ). There was also a significant difference between average digital device continuous use ( $F = 18.92$ ,  $p < 0.001$ ) with the average continuous usage of digital devices for more than 2 hours showing the highest mean Digital Eye Strain score among the students. The results were significant for the duration of sleep ( $F = 15.16$ ,  $p < 0.001$ ): students that slept less reported more visual discomfort. Similarly, the mean scores of Digital Eye Strain were significantly higher among students who use digital devices 3+ times per day than among students who use digital devices fewer than 3 times per day ( $F = 11.27$ ,  $p<0.001$ ). There was a significant difference between the mean

scores of Digital Eye Strain ( $F = 6.48, p = 0.001$ ) among academic year with higher scores for students in higher academic degrees than for junior students. The results of the overall ANOVA analysis indicated that long exposure to screens, long continuous use of the device, inadequate sleep and increased use of multiple digital devices and high academic level were all significantly related to Digital Eye Strain in the university students in Saudi Arabia.

## DISCUSSION

The aim of this study was to evaluate digital screen exposure and its correlation with the visual health of University students in Saudi Arabia, and the study found a significant correlation between long duration of exposure to digital screens and the deterioration of the ergonomic practices of DES among the students of University. The amount of screen time was the most significant predictor of items concerning visual health outcomes, both for the Chi-square analysis and for the One-Way ANOVA; the students that spent more time in front of screen had higher rates than the students that spent less time in front of screen, and higher mean scores. The findings are consistent with previous studies that have found "long duration of screen time" to be one of the most important risk factors for eye fatigue, blurred vision, dry eyes, and headaches among university students.

The study also found that factors such as shorter viewing distances, not following the 20-20-20 rule, too bright of a screen, not taking a break often enough, and greater visual symptoms were all associated with the study. Results indicate that behavioral and ergonomic factors are important contributors to the development of Digital Eye Strain and can be modified. Moreover, One-Way ANOVA analysis showed that the students with the longest screen use (more than one hour a day), the lowest amount of sleep (less than 7 hours per night), the highest number of digital devices used, and the highest academic year were found to have significantly higher mean Digital Eye Strain scores, indicating that these factors are cumulative factors and may be associated with increased academic burden and prolonged digital device use.

The prevalence of DED was higher among female students than in previous studies, but further investigation would be needed to determine the factors that may account for this difference. The results in general suggest that Digital Eye Strain is a significant problem in the public health domain for university students in Saudi Arabia. Guidance on healthy digital use (such as avoiding unnecessary screen time, maintaining a proper viewing distance, visual breaks, changing the brightness of screens, getting plenty of rest, and awareness of good ergonomic habits) can help minimize visual discomfort and enhance students' visual health and learning. Longitudinal studies with objective ophthalmic assessment are recommended in the future to validate these findings and assess long-term effects of digital screen exposure.

## CONCLUSION

The present cross sectional study revealed that digital screen exposure showing significant association with visual health in university students in Saudi Arabia. The factors associated with increased Digital Eye Strain and related visual symptoms were: prolonged daily screen time, shorter viewing distance, not following the 20-20-20 rule, high screen brightness, infrequent breaks, use of multiple digital devices, shorter sleep duration and higher academic level. The results of this study suggest that the amount of screen time, as well as ergonomic and behavioral factors that can be changed, are all associated with visual discomfort in university students. Therefore, implementing strategies to encourage healthy digital device use, visual ergonomics awareness, regular breaks from screen time and strategies to prevent Digital Eye Strain will help alleviate the burden of Digital Eye Strain and enhance students' visual health, well-being, and academic performance.

### Future Scope of Study

Longitudinal or prospective study designs are recommended for future studies to assess the causality between digital screen exposure and visual health outcomes. The results of this study could be more generalizable if another larger and more diverse sample of university students from other regions of Saudi Arabia participated in the multicenter studies. The use of objective ophthalmic assessment measures such as visual acuity, tear film evaluation, blink rate, and accommodation testing should also be included, along with subjective questionnaires, to yield more complete data.

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