RESEARCH PAPER

Blue-Light Filtering Versus Standard Spectacle Lenses and Dry Eye Symptoms Among University Students: A Comparative Cross-Sectional Study

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Abstract
Digital eye strain and dry eye disease (DED) are increasingly prevalent among young adults due to prolonged use of digital devices. Blue light filtering lenses have been proposed as a preventive measure to reduce ocular discomfort and maintain visual stability, but their clinical benefits remain debated.
Aim: This study aimed to examine and compare the impact of Blue Cut lenses versus standard lenses in reducing symptoms of DED among university students, with a focus on eyestrain, discomfort, and dryness associated with extended screen exposure.
Methods: A cross-sectional, comparative study was conducted among 80 university students in Guwahati, aged 18–35 years. Participants were divided into two groups based on lens type: Blue Cut (n = 47) and standard lenses (n = 33). A structured questionnaire, including the Ocular Surface Disease Index (OSDI), was used to assess subjective symptoms. Objective diagnostic tests, including Schirmer's and Tear Break-Up Time (TBUT), were performed to evaluate tear film function. Data were analyzed to compare symptom prevalence and severity across groups.
Results: The mean OSDI score was 21.34 ± 15.05, indicating an overall mild level of dry eye. While 42.5% of participants were in the normal category, 57.5% reported mild to severe symptoms. Schirmer's testing showed 46.25% of participants with abnormal tear secretion, and TBUT revealed 58.75% with unstable tear films. Blue Cut lens users showed a higher proportion of normal outcomes (28.75%) compared to standard lens users (17.5%), particularly in the 21–25 year age group. However, the difference was not statistically significant.
Conclusion: DED and digital eye strain were common among university students, with more than half experiencing some degree of symptoms. Blue Cut lenses demonstrated a modest benefit in maintaining visual comfort, but the difference in dry eye severity between Blue Cut and standard lens users was not statistically significant. The combination of questionnaires and objective diagnostic tests is essential for accurate evaluation of DED. Preventive strategies, including ergonomic measures and regular eye care, remain vital for reducing ocular discomfort in digital device users.

Keywords: Dry eye disease, digital eye strain, blue-light filtering lenses, Schirmer's test, tear break-up time, university students.
How to cite this article: Bhayolina Sarma Khilbar Sonowal Haziel Rynjah Krishanjit Parasar AyuWilson Yukti Singh. Blue-Light Filtering Versus Standard Spectacle Lenses and Dry Eye Symptoms Among University Students: A Comparative Cross-Sectional Study. Int J Drug Deliv Technol. 2026;16(79s):485-490. DOI: 10.25258/ijddt.16.79s.52.

Introduction

The increasing use of smartphones, computers, tablets, and other digital devices has changed the way university students study, communicate, and spend their leisure time. Although digital technology provides substantial academic and social benefits, prolonged screen use is frequently associated with ocular discomfort, dryness, blurred vision, visual fatigue, and other symptoms of digital eye strain. (1) The growing amount of screen-based activity among young adults has therefore brought increasing attention to dry eye symptoms in this population.

Dry eye disease is a multifactorial disorder involving the tear film and ocular surface and may result in discomfort, visual disturbance, tear-film instability, and reduced quality of life. It is no longer considered a condition restricted to older individuals, as symptoms are increasingly observed among younger populations. (2) Environmental exposure, prolonged reading, driving, and sustained visual attention to electronic screens may contribute to ocular surface discomfort.

Dry eye may occur through different mechanisms, including aqueous tear deficiency and excessive tear evaporation. Evaporative dry eye is commonly associated with dysfunction of the meibomian glands, which can reduce the lipid component of the tear film and increase tear evaporation. (2,3) These different mechanisms may coexist and contribute to the symptoms experienced by patients.

The increased use of digital screens has also encouraged interest in blue-light filtering spectacle lenses. These lenses selectively reduce the transmission of portions of short-wavelength visible light and are commercially available as blue-light filtering or blue-light blocking lenses. [3,4] They are commonly promoted as a way of improving visual comfort during prolonged digital-device use. However, the clinical usefulness of these lenses in reducing dry eye symptoms remains uncertain.

Blue light occupies the shorter-wavelength region of the visible spectrum and has attracted considerable attention because of proposed effects on visual comfort, circadian rhythms, and retinal function. [5] Blue-light filtering lenses have consequently been marketed for reducing eye fatigue and improving visual performance during digital-device use. [2,5] At the same time, previous research has questioned whether blue light emitted by digital screens is itself the primary cause of digital eye strain. [2,6,7]

The effects of blue-light filtering lenses may also extend beyond subjective comfort. Because these lenses modify the transmission of short-wavelength light, questions have been raised regarding their influence on contrast sensitivity, color perception, photo stress recovery, and motion perception. [8] These considerations highlight the need to evaluate their clinical usefulness rather than assuming that blue-light filtering automatically provides protection against digital eye-related symptoms.

In this context, the present study compared dry eye symptoms and tear-film characteristics among university students wearing blue-light filtering and standard spectacle lenses. Particular attention was given to subjective symptoms assessed using the OSDI and objective assessment using Schirmer's test and TBUT.

Materials and Methods

Study design and participants

A comparative cross-sectional study was conducted among 80 university students in Guwahati, Assam. Participants were between 18 and 35 years of age and included both male and female spectacle wearers. The study used a single-point assessment to compare dry eye symptoms and clinical tear-film findings between participants using blue-light filtering and standard spectacle lenses.

Participants with active ocular surface disease, contact lens wear, previous ocular surgery, or those who did not wear spectacles were excluded. Participants were selected using the sampling approach described in the original study as random sampling.

Clinical assessment

Demographic information, ocular history, spectacle prescription, lens type, occupation, lifestyle factors, and relevant environmental factors were recorded. Visual acuity was assessed before the dry eye examination. Subjective symptoms were evaluated using a structured questionnaire incorporating the Ocular Surface Disease Index. Objective assessment included Schirmer's test I for tear secretion and TBUT for evaluation of tear-film stability. Written informed consent was obtained from the participants after explaining the study procedure and purpose.

The questionnaire included questions related to ocular symptoms, difficulties during visual tasks, and environmental conditions. Symptoms included light sensitivity, gritty eyes, painful or sore eyes, blurred vision, poor vision, reading difficulties, and problems during computer or ATM use. Environmental questions assessed discomfort in windy, low-humidity, and air-conditioned environments.

Ocular Surface Disease Index

The OSDI was used to assess the severity of dry eye symptoms. The scores obtained from the 80 participants ranged from 0.00 to 58.33, with a mean score of 21.34 ± 15.05. Participants were categorized into normal, mild, moderate, and severe symptom groups according to the classification used in the study.

Schirmer's test

Schirmer's test I was performed to evaluate tear secretion. A filter paper strip was positioned at the lower eyelid and the amount of wetting was recorded after five minutes. The study classified tear secretion according to the recorded wetting length, with higher values considered indicative of better tear production.

Tear break-up time

TBUT was assessed using fluorescein under cobalt-blue illumination. Participants were instructed to avoid blinking while the tear film was observed, and the time until the appearance of the first break in the tear film was recorded. TBUT was subsequently categorized according to the grading system used in the study.

Statistical analysis

Data entry and descriptive analysis were performed using Microsoft Excel 2016, while IBM SPSS was used for statistical analysis. A chi-square test was used to examine the association between lens type and dry eye severity. A p-value below 0.05 was considered statistically significant.

Results

A total of 80 university students participated in the study. There were 47 females (58.75%) and 33 males (41.25%), with most participants belonging to the 20–25-year age group. The mean age of the study population was 23.39 ± 2.65 years, as shown in figure1.

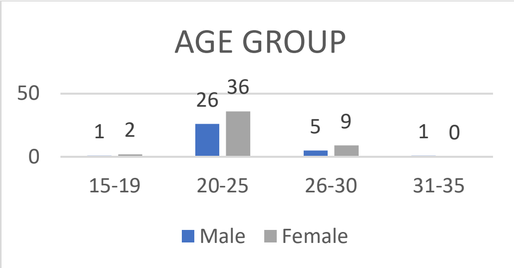
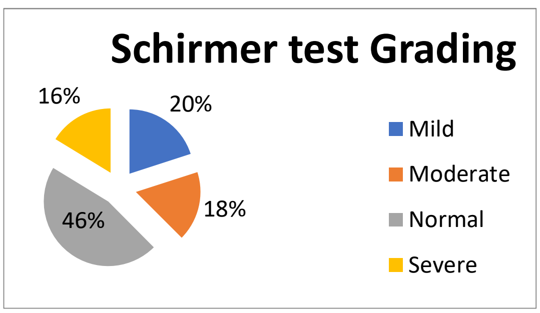


Fig 1: *Graphical representation of the distribution of the age group from 18-35 years*

The participants reported a range of ocular symptoms during the preceding week. Light sensitivity was reported by 65% of participants at varying frequencies, whereas 35% had not experienced it. Grittiness was reported by 42.5%, while 57.5% reported no such symptom. Painful or sore eyes were reported by 40% of participants to varying degrees.

Blurred vision was one of the more frequently reported symptoms. Of the 80 participants, 34 (42.5%) reported no blurred vision, while 46 (57.5%) experienced it at least occasionally. Similarly, 57.5% reported some degree of poor vision or visual change during the previous week.

Reading-related difficulties were reported by 38.75% of participants, while 61.25% reported no difficulty. Problems during computer or ATM use were reported by 53.75% of participants, with 20% experiencing difficulties approximately half of the time and smaller proportions reporting more frequent symptoms.



Environmental conditions also appeared to contribute to ocular discomfort. Sixty percent of participants reported some degree of discomfort in windy conditions. Similarly, 52.5% reported discomfort in low-humidity environments, while 48.75% experienced some degree of discomfort in air-conditioned environments.

Dry-eye severity	Blue-cut	Standard
Normal	23	14
Mild	16	12
Moderate	1	1
Severe	7	6

Figure 2 : *Comparison of dry-eye severity between blue-cut and standard spectacle lens users.*

OSDI findings

The mean OSDI score was 21.34 ± 15.05. Among the 80 participants, 34 (42.5%) had scores within the normal range, 14 (17.5%) had mild symptoms, 12 (15%) had moderate symptoms, and 20 (25%) had severe symptoms. Overall, 57.5% of participants therefore reported some degree of dry eye symptoms.

The distribution of symptoms indicates that although the overall mean score suggested mild dry eye, a considerable subgroup experienced moderate or severe symptoms. This variation suggests that the burden of ocular discomfort differed considerably among individual students.

OSDI category	n	%
Normal	34	42.5%
Mild	14	17.5%
Moderate	12	15.0%
Severe	20	25.0%

Figure 3: *Distribution of dry-eye symptom severity based on Ocular Surface Disease Index (OSDI) scores.*

Objective dry eye findings

Schirmer's test showed normal tear secretion in 37 participants (46.25%), while 16 (20%) had mild, 14 (17.5%) had moderate, and 13 (16.25%) had severe abnormality. TBUT results showed normal tear-film stability in 33 participants (41.25%), while 25 (31.25%) had mild, 9 (11.25%) had moderate, and 13 (16.25%) had severe abnormality. These objective findings demonstrate that abnormalities in tear secretion and tear-film stability were present in a substantial proportion of the study population, supporting the subjective reports of ocular discomfort.

Figure 4: *Distribution of objective dry-eye findings based on Schirmer's test and tear break-up time (TBUT).*

Comparison between lens groups

The study compared dry eye severity between participants wearing blue-light filtering and standard lenses. The reported chi-square contingency table included 23 blue-light filtering lens users and 14 standard-lens users in the normal category, 16 and 12 in the mild category, 1 and 1 in the moderate category, and 7 and 6 in the severe category, respectively. The overall chi-square analysis produced a p-value of approximately 0.97, indicating no statistically significant association between lens type and dry eye severity.

Although the proportion of normal outcomes was higher among blue-light filtering lens users in the reported analysis, the differences across the severity categories were small. The findings therefore do not provide sufficient statistical evidence to conclude that blue-light filtering lenses reduce dry eye severity.

Discussion

The present study demonstrates that dry eye symptoms and visual discomfort are common among university students. More than half of the participants reported some degree of dry eye symptoms on the OSDI, while symptoms such as blurred vision, light sensitivity, and discomfort during computer use were also frequently reported. These findings are relevant in the context of increasing dependence on digital devices among young adults. [9]

One of the important observations was the variation in symptom frequency. Although severe and persistent symptoms were less common, occasional discomfort was reported by a considerable proportion of participants. For example, 57.5% reported blurred vision to some degree, while 53.75% experienced some difficulty during computer or ATM-related activities.

Environmental conditions may have contributed to these complaints. Windy conditions were associated with discomfort in 60% of participants, while more than half reported symptoms in low-humidity environments. Almost half also reported discomfort in air-conditioned environments. These findings are consistent with the role of environmental exposure in increasing tear evaporation and aggravating ocular surface symptoms.

The combination of subjective and objective findings provides a more complete picture of the participants' ocular surface status. The mean OSDI score suggested mild dry eye symptoms overall, but 57.5% of participants had some degree of symptoms. Objective testing similarly demonstrated abnormalities in tear secretion and tear-film stability.

An important consideration is that subjective symptoms and objective clinical findings do not necessarily correspond perfectly. A participant may experience discomfort despite relatively preserved tear secretion, while another may have an abnormal clinical finding without reporting severe symptoms. This supports the use of both symptom-based questionnaires and objective clinical tests when evaluating dry eye.

The comparison between blue-light filtering and standard lenses did not demonstrate a statistically significant difference in dry eye severity. Although a higher proportion of normal outcomes was observed among Blue Cut lens users, this difference was not statistically significant

Blue-light filtering lenses are commonly promoted for reducing digital eye strain, particularly during prolonged screen exposure. However, the evidence presented in the original study itself indicates that the relationship between blue light and digital eye strain remains uncertain. Therefore, it would be inappropriate to describe blue-light filtering lenses as a definitive treatment for dry eye.

The findings also suggest that digital eye strain should be considered as a multifactorial problem. Screen duration, reduced blinking, glare, viewing conditions, environmental humidity, and individual ocular surface characteristics may all contribute to symptoms. Consequently, strategies such as appropriate screen ergonomics, regular breaks, adequate lighting, and routine eye examinations remain important regardless of the type of spectacle lens being worn.

The present study also highlights the importance of objective clinical assessment. OSDI provides valuable information about the patient's subjective experience, whereas Schirmer's test and TBUT provide information about tear production and tear-film stability. Using both approaches can help clinicians identify differences between symptoms and clinical findings and may provide a more reliable assessment of ocular surface health.

From a clinical perspective, blue-light filtering lenses may be considered as one component of visual comfort for individuals who prefer them, but they should not replace established measures for reducing digital eye strain. The study findings support a broader approach to digital eye health that includes appropriate visual habits, ergonomic adjustments, regular blinking, adequate environmental conditions, and professional eye assessment when symptoms persist.

Limitations

The cross-sectional nature of the study limits the ability to establish a causal relationship between lens type and dry eye symptoms. The sample consisted of university students from Guwahati, which may also limit the generalizability of the findings to other age groups and populations.

In addition, participants were already wearing different types of spectacle lenses rather than being randomly assigned to a lens intervention. Differences in screen exposure, lifestyle, environmental conditions, spectacle prescription, and individual susceptibility to dry eye may therefore have influenced the findings.

Larger longitudinal or randomized studies would help determine whether blue-light filtering lenses provide a clinically meaningful benefit over standard lenses during prolonged digital-device use.

Conclusion

Dry eye symptoms and visual discomfort were common among the university students included in this study. More than half of the participants reported some degree of dry eye symptoms, while objective assessment identified abnormalities in tear secretion and tear-film stability in a substantial proportion of participants.

Although blue-light filtering lens users showed a greater proportion of normal outcomes in the reported comparison, the difference in dry eye severity between blue-light filtering and standard lenses was not statistically significant. Therefore, the findings suggest that blue-light filtering lenses may provide some degree of visual comfort for certain users, but their role in preventing or reducing dry eye should not be overstated.

A comprehensive approach to digital eye health remains important for university students. Appropriate screen ergonomics, regular breaks, adequate lighting, environmental control, and routine ocular assessment may help reduce the burden of digital eye strain and identify students who require further management.

Conflict of Interest

The authors declare that they have no conflict of interest related to this study, its findings, or the publication of this manuscript.

Funding

The authors received no specific funding for this study. The research was conducted without financial support from any public, commercial, or not-for-profit funding agency.

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