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ORIGINAL ARTICLE

Effectiveness of Blue Light Blocking Filter on Dry Eye Disease and Asthenopic Symptoms in Screen Users

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ABSTRACT

Objective: To evaluate the effectiveness of Blue Light Blocking (BLB) filters on the severity of dry eye disease (DED).

Study Design: Longitudinal study.

Methods: A longitudinal study was conducted using purposive sampling from September 2022 to May 2023 at the University of Faisalabad. A total of 60 patients with varying severity of dry eye disease were included. DED was assessed using the Ocular Surface Disease Index (OSDI), Tear Breakup Time (TBUT), and Schirmer Strip Test-1 (SST-1). Following baseline assessment, BLB filters were prescribed for 4–5 hours daily. Follow-up assessments were conducted at 1 week, 2 weeks, and 1 month. Repeated-measures ANOVA was used for statistical analysis.

Results: Statistical analysis revealed a significant improvement in the severity of DED following the use of BLB filters ($P<0.05$). The baseline OSDI value was 2 ± 0.8, which decreased to 0.8 ± 0.6 after 1 month. The baseline Schirmer Strip Test-1 value was 14.5 ± 7.9, increasing to 23.6 ± 7.8 after 1 month. Similarly, baseline Tear Film Stability (TBUT) was 3.7 ± 1.2, increasing to 7.8 ± 2.3 after 1 month. The improvements in OSDI, SST-1, and tear film stability were statistically significant ($P=0.002$).

Conclusion: The use of BLB filters was associated with a significant improvement in dry eye disease. Improvements were observed in OSDI scores, Tear Film Stability (TBUT), and Schirmer Strip Test-1 results.

Keywords: Asthenopia, Dry eye syndromes, Eyeglasses, Screen time, Tears.

INTRODUCTION

The physiological changes of the tear film resulting in reduced tear volume and reduced tear film stability is known as dry eye disease. Dry Eye Disease (DED) can be caused by multiple factors disturbing the physiology of the tear film [(1)]. Dry eye disease associated with the LED users is significantly associated to these pro-inflammatory cytokines, resulting in reduced tear film volume, stability, inflammatory and oxidative ocular surface damage [(2)]. Thus, one significant cause of Dry Eye Disease includes long term exposure to blue light [(3)]. This is especially relevant today given the substantial number of hours spent by many people looking at these screens in daily life [(4)].

Blue light has a short wavelength and produces a lot of energy that can be seen by the human eye (measured in nanometers). The shorter the wavelength of the light, the more energy the blue light produces [(5)]. The wavelength of 300 nm to 400 nm penetrates the cornea [(3)]. It acts as a pathogenic contributor by reducing mitotic activity, cells viability and increased levels of local oxygen

species such as hydrogen peroxide, super oxide anion, and hydroxyl radicals. These reactive oxygen species cause corneal cells damage [2]. Screen time not only effect on dry eye but also effect on physical activity and learning skills. Longer screen time is as important as blinking rate. As the improper blinking rate leads to inadequate spreading of tear film over the ocular surface [6]. The presence of asthenopia symptoms are attentively associated with lack of working capacity and effects academic performance thus making asthenopia symptoms a major public health concern [7]. On the other hand, ocular discomfort and pain are considered to have negative results on mental health and quality of life [8]. The production of hormone that is called melatonin which regulates the sleep cycle is decreased, particularly in the people who are exposed to blue light for longer period of time. Disruption in the sleep cycle can increase the production of corticosteroids which can decrease the parasympathetic nerve excitability and also directly decrease tear secretion and increase the risk of dry eye. The long term exposure cannot only damage the specific membrane but can also increase the development of cataract and macular degeneration [9]. Glaucoma and keratitis can also be caused by excessive exposure to blue light, following a series of alterations [10]. The blue light exposure can also change the axial length of the eye. The short wavelength of light can reduce the axial length of the eye by retinal dopamine release mechanism. The blue light can also reverse the myopia into hyperopia due to in front focusing of light from retina [11]. Many micro ganglia in outer nuclear layer are arranged specific pattern in AMD patients. This arrangement is distorted by the displacement of the micro ganglia cells, after activation with the blue light in the phagocyte portion of outer nuclear layer. More distorted this arrangement, lower the thickness of the outer nuclear layer [3].

Thus, regarding potential hazards associated with the blue light emitted from the screens of different digital devices widely used today. The need of the hour is to introduce best treatment options and different life style modifications to prevent ocular damage. Such an option includes blue light blocking filter glasses .Blue light blocking filter glasses are proven to be efficient in reducing the negative effect [12]. Blue light blocking (BLB) filters allow minimum amount of blue light to enter our eyes [3]. Tear film dynamics have direct relation with light scattering. Scattering is reduced after a blink and thus visual performance is improved. By using blue light filters the scattering can be decreased by averting tear film instability [13]. Yellow filter or tint in induced spectacles, are a form of BLB filter. The photo toxicity induced by the blue light cannot be diminished by its use but it can be reduced, as the viable cells of the cornea are protected by the use of shades [14]. These spectacles are statistically proved to absorb blue light and block harmful ultra-violet light [15]. Yellow filter is also proven to be beneficial for many outdoor activities including driving. Yellow filters improve contrast and brightness of objects, thus responsible for enhancing visual performance [16]. Yellow filter not just improves contrast sensitivity but also found to increase motion sensitivity, convergence and accommodation in children with reading difficulties [17]. People with Delayed Sleep Phase Disorder (DSPD) can also benefit from BLB glasses. Out of which amber (yellow) lens is proven to be the most beneficial. These amber lenses potentially regulate circadian cycle and benefits DSPD patients as an effective and safe intervention [18].

MATERIALS AND METHODS

A Longitudinal study design was used because it contains more than one follow up and the sampling technique was purposive sampling technique, which was carried out from September 2022 to May 2023 at the University of Faisalabad. Total 60 patients of age group 18-35 were included, which were divided into (N-20) Mild, (N-20) Moderate and (N-20) Severe dry eye groups. Inclusion criteria was both genders, age 18 to 35 years, dry eye disease, emmetropes and screen users (>4 hours daily). Contact lens users, allergic patients, refractive error or surgery patients, pregnant women, mentally retarded, active ocular infection and all Systemic and syndromic patients i.e. PCOS, Arthritis, Ptosis who had a potential association with DED were excluded. After taking inform consent and history of Dry Eyes, international proforma carried out for the evaluation of patients complaints and ocular surface disease index (OSDI) questionnaire used for selection then procedure started with anterior segment examination, which was done by using Slit Lamp and pre data of dry eye by using schirmer test and fluorescence strips was taken., Number of blinks and posture of patient were assessed during procedure. The Schirmer test for the production of tear's and TBUT test for the stability of tear film, were used to evaluate the severity and type of Dry Eye Disease. After taking all the measurements, participant advised to use the blue light blocking glasses 4 to 5 hours daily for 1 week during screen time. The first follow-up was done after one week to check the effect of blue light blocking filter on the severity of Dry Eye Disease. Then Second follow-up was done after 2 weeks. Third follow-up was done after completing one month. Then the symptoms and severity of Dry Eye Disease was reassessed and compared with the results of previous follow-ups. A patient with less than 10-sec Tear Breakup Time and less than 10 mm Schirmer test were considered as mild dry eye, Patients with 5-10 sec Tear Breakup Time

and 5-10 mm Schirmer test considered as moderate dry eye and patients with less than 5-sec Tear Breakup Time and less than 5 mm Schirmer test considered as a severe dry eye disease. Data analysis was performed using IBM SPSS version 22, with descriptive statistics analysis of Repeated measure Anova test was employed to summarize and characterize the study variables.

RESULTS

The purpose of this study was to evaluate the effectiveness of blue light blocking filters on the severity of dry eye disease on both genders. Total 60 patient was taken in this study between the age of 18-35 years through non-probability sampling technique. The mean values (M) of age distribution was 1.02 ± 0.128. The normality of data was checked by applying Shapiro-Wilk test. Analysis showed significance value of >0.05, representing normal distribution of data.

The Descriptive statistical analysis of Repeated Measure Anova test showed that baseline value of tear stability was 3.7 ± 1.2 and after the use blue blocking glasses on first follow was 4.9 ± 1.2 on second 6.3 ± 2.2 and on the third follow up 7.8 ± 2.3 (Table no.1). This showed a significant increase in the value of tear stability after the use of blue blocking filter glasses (Figure no.1). The value of significance was found to be P= 0.000.

However, the mean values of the tear production were on baseline 14.5 ± 7.9. After the use blue blocking glasses, the mean values were on first follow 18 ± 8 and on second 20.2 ± 7.3 and on the third follow up 23.6 ± 7.8 (Table no.2). This showed a significant improvement in the value of tear production after the use of blue blocking filter glasses (Figure no.2). The value of significance for tear production was found to be P= .000.

These results conclude that use of blue light blocking filters during your screen time is not only beneficial for improving tear film stability but also for tear film production by minimizing the blue light reaching ocular surface.

Table 1: Descriptive Statistics of Tear Stability.

	Mean	Std. Deviation
Tear stability base line	3.7	1.2
Tear stability 1	4.9	1.2
Tear stability 2	6.3	2.2
Tear stability 3	7.8	2.3

Table 2: Descriptive Statistics of Tear Production.

	Mean	Std. Deviation
Tear production base line	14.5	7.9
Tear production 1	18.0	8.0
Tear production 2	20.2	7.3
Tear production 3	23.6	7.8

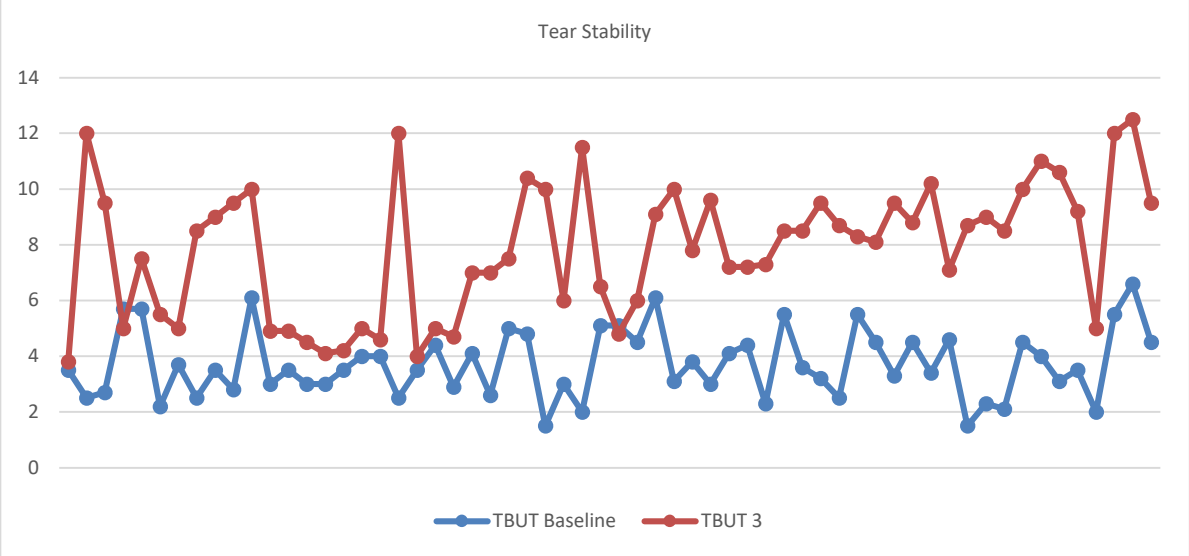


Figure 1: Difference between the values of Tear Stability on third follow-up (TBUT 3) from baseline data (TBUT Baseline)

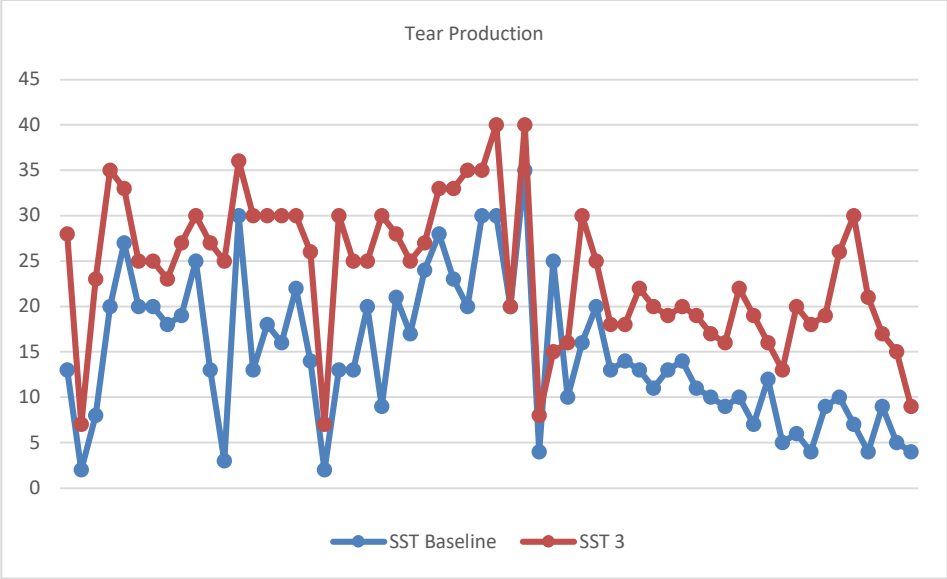


Figure 2: Difference between the values of Tear Production on third follow-up (SST 3) from baseline data (SST Baseline)

DISCUSSION

In this study blue light blocking filters importance was highlighted in effectively controlling dry eye disease in screen users. The use of these filters has not only helped improving dry eye diseases symptoms but also serve as a cost friendly innovative for dry eye disease management in screen users. A study conducted by shanti et al in 2017 resulted that the dry eye disease prevalence was high in female and old age ranging from 18 to 90 years [19]. Female participants of age group 18-35 years old were prime focus in this study as well.

This study focuses on the participants with extensive use of digital screens. Junxin et al in 2020 demonstrated that more than 1-hour use of digital devices over one year was independently associated with dry eye disease [20]. Maroof at el in the same year also stated that digital screens emit high energy and shorter wavelength blue light which causes dry eye disease [21]. In 2019, a study demonstrated that wavelengths between 400 nm and 500 nm were 99% blocked by blue light blocking filters, which was ±1 standard error of measurement (p= 0.02). Blue light has short wavelength and high photon energy and thus higher luminance than other wavelength of visible light [22]. Thus, this study considered blue light blocking filter glasses to block damaging light wavelength up-to 490 nm of digital screens of 270 cd/m^2, used by participants.

Recent studies conducted in 2021 shows a possible relationship between less exposure to blue light and improvement in tear film stability as well. These studies showed significant results ($p<0.05$) [23]. In this study STT values show $p<0.000$ and TBUT values for tear film stability shows $p<0.00$, recommending a highly significant result.

Shanti et al in 2017 used ocular surface disease index (OSDI) to assess and evaluate the symptoms of dry eye disease in the selected candidates along tear breakup time, schirmer, and corneal staining. The result shows these tests to be an appropriate means to indicate dry eye disease improvement p = (0.001) [19]. Considering it, in this study an OSDI questionnaire based on the official standard to categorize participants as mild, moderate or severe dry eye disease patients is used. It showed a value of 0.8 ± 0.6 after one month, compared to baseline values of 2.0 ± 0.8.

Moreover, A study in 2018 concluded that asthenopia symptoms also improves along tear production by using blue light blocking filters[22]. Palavet et al stated that blue light blocking filters decrease asthenopia symptoms while using digital screens [5]. In 2019 Hashemi et al conducted that almost ten symptoms including foreign body sensation (FBS), double vision, blurry vision, swelling of eye, eye pain, dry eye, decreased visual acuity (VA), difficulty in visual perceptions, tearing and photophobia are considered as asthenopia symptoms. The results indicated that these symptoms have strong association with university students [24]. Regarding these studies, this study considered university student experiencing dry eye disease with long exposure to digital screens.

For future correspondence, association of asthenopia, dry eye disease and blue light blocking filters should be assessed to gain more in depth understanding of the correlation between the three identities,

strengthen positive impact of blue light blocking filters on dry eye disease and in patients of asthenopia.

CONCLUSIONS

It was concluded that the dry eye disease and associated asthenopia, caused by long exposure of blue light (BL) in screen users, can be managed by the use of blue light blocking (BLB) filter. Blue Light Blocking Filters are not only beneficial but also cost effective. So, it is recommended to prescribe Blue light blocking filter glasses in clinic as an additional treatment optional.

DECLARATION

Conflict of Interest: The authors declare no conflict of interest.

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Author's Contribution: All authors contributed equally in the complication of current study.

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