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Comparative Effect of Green and Blue Filters on Near Point of Accommodation among Emmetropes and Myopes

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ABSTRACT

Coloured filters are optical devices that selectively transmit certain wavelengths of light while absorbing others. Green and blue filters can reduce glare and improve contrast. **Objectives:** To determine the effect of green and blue filters on relieving excessive near point of accommodation among emmetropes and myopes. **Methods:** This analytical cross-sectional study was conducted at the Rashid Latif Khan University, Lahore, Pakistan, from May 2023 to January 2024. 110 participants of both genders, aged 15-30 years, were included. The participants were divided into emmetropes and myopes, with 55 participants in each group. The near point of accommodation (NPA) was assessed objectively using the RAF rule. Both groups were examined initially without any filter and then using green and blue filters. Data were analysed using SPSS-24. A repeated-measures ANOVA test was applied to compare the effect of green and blue filters in emmetropes and myopes. **Results:** Mean NPA ± SD without filter, with green filter, and with blue filter in emmetropes was 14.89 ± 1.64, 12.07 ± 1.15, and 12.25 ± 1.03, respectively, with ($p<0.001$) while, mean NPA ± SD without filter, with a green filter, and with a blue filter in myopes was 13.92 ± 1.68, 11.92 ± 0.58, and 12.53 ± 0.55, respectively, with ($p<0.001$) suggesting that both green and blue filters contribute to a reduction in excessive accommodation among emmetropes and myopes. **Conclusions:** The use of green and blue filters could decrease excessive NPA both in emmetropes and myopes (mild to moderate myopes).

INTRODUCTION

Myopia is the most prevalent type of refractive error. Recently, myopia has become more common in young adolescents, particularly in East and Southeast Asia [1, 2]. According to recent estimates, 49.8% of the population will have myopia in 2050 [3]. Uncorrected myopic error contributes significantly to visual impairment and reduces the quality of life. Children with myopia usually read at a closer distance than emmetropic children. Furthermore, it has been observed that myopia development in children is considerably faster at closer work distances [4-6]. Children often view objects at closer distances, which get smaller as they focus more intently. When spatial frequencies increase, this causes larger accommodation lags and lowers vision quality [7]. The ability of the eye to adjust the lens's refractive power to focus on objects at different distances is known as accommodation. The retina is imaged clearly at various viewing distances by a complex series of sensory, neuromuscular, and biophysical events that alter the refracting power of the eye [8]. Myopia causes poor distance vision, which can be corrected by

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using visual corrective aids like spectacles, contact lenses, and refractive surgeries. Wearing glasses can improve vision and academic performance [8]. Tinted glasses and coloured overlays are commonly used to support individuals experiencing reading difficulties linked to increased retinal sensitivity to specific light wavelengths. By modifying the light that reaches the retina, tinted filters help create a more stable and visually comfortable environment that allows users to focus for longer periods with less effort [9]. Green and blue filters are among the most frequently used options, each offering distinct optical benefits based on their selective transmission of specific wavelengths [10, 11]. Green filters transmit light around an optimal wavelength of approximately 531 nm, which corresponds to the sensitivity of the eye's M-cones, located centrally in the retina. Thus, provides comfortable vision, improving clarity, easing eye strain, and creating a soothing visual experience that supports extended reading, especially in bright or high-contrast environments [12]. In contrast, short-wavelength blue light in the 450–500 nm region is absorbed by blue-blocking filters [13]. Overexposure to blue light, especially from digital screens, has been linked to glare sensitivity, visual tiredness, and irregular sleep patterns [14]. Blue-blocking filters diminish pain during prolonged near work, lessen digital eye strain, and promote healthy sleep by reducing blue-light interaction with circadian rhythms by limiting these wavelengths[15].

There is limited evidence comparing the differentiation effect between green and blue filters of the near point of accommodation (NPA), particularly on emmetropic and myopic groups. Over-accommodation leads to visual fatigue and can also increase the rate of myopia in people with spectacles, but relatively little has been done to understand the relative effectiveness of a green and a blue filter in reducing the accommodative demand of myopes with spectacles and emmetropes. This study aimed to assess and compare the effect of green and blue filters on excessive accommodation in emmetropes and optically corrected myopes.

METHODS

This analytical cross-sectional study was conducted at Rashid Latif Khan University, Lahore, Pakistan, in the period from May 2023 to January 2024, after obtaining technical and ethical approval from the Ethical Review Board (IRB/RLIAHS/860/2024). The sample size was 110, calculated according to Robert Masson's equation: N=Z2PQ/d2 where N is the required sample size, Z is the standard normal deviate corresponding to a 95% confidence level (Z = 1.96), P is the estimated population proportion assumed to be 0.5 in the absence of prior data, Q is (1 – P) and therefore equal to 0.5, and d is the allowable margin of error. The margin of error (d) was set at 0.093, as margins between 5% and 10% are considered acceptable and consistent with the literature [16]. Participants of both genders aged 15-30 years were included in the study through the purposive sampling (non-probability) technique. Purposive sampling was used to include participants with specific refractive error (myopia) and those without it (emmetropia), ensuring the sample is relevant to research objectives. Emmetropic and mildly to moderately myopic (BCVA 6/6) subjects with excessive accommodation (>10 dioptres) were included in the study. All ocular diseases, extraocular muscle instability, tropias, amblyopia, uncorrected myopes, myopia greater than 6 dioptres (D), hypermetropic patients, astigmatic patients, contact lens users, mentally retarded patients, and those suffering from any systemic diseases were excluded from the study. The procedure was explained to the eligible participants, and informed written and verbal consent was obtained. The data collection was done through a self-designed examination-based proforma approved by the technical and ethical committee of the institute. The questionnaire contained history taking (personal data, past medical and ocular history), a thorough ocular examination including best corrected visual acuity (BCVA), refractive error, near point of accommodation (NPA) with and without green and blue filters, and detailed anterior and posterior segment slit lamp evaluation. Subjects were divided into two groups, i.e., emmetropes and myopes, with 55 participants in each group. NPA was assessed using the Royal Air Force (RAF) rule at three instances in both groups: initially without any filter, then using green filters, and lastly using blue filters. RAF was a 50-centimeter-long rule featuring a slider that rotates and holds a four-sided cube with a distinct target. The patient was instructed to focus on the letters that were slowly moving closer to their nose until he/she could no longer maintain a clear focus on the letter or symbols. The NPA is obtained when the letters get blurred, initially without using any filter, then using green and blue filters separately at each turn. The near point of accommodation was taken in diopters (D). Descriptive and inferential statistical analyses were performed using SPSS for Windows version 24.0 (SPSS Inc., Chicago, IL, USA). Data were reported as frequency and mean ± standard deviation (SD). The data were normally distributed, and a parametric test (repeated measure ANOVA) was applied. The repeated measure ANOVA was applied as NPA was assessed three times in the same participants (without filter, with green filter, and with blue filter) in both myopic and emmetropic groups. A p-value of <0.05 was considered statistically significant with a 95% confidence level.

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RESULTS

Data of a total of 110 patients, divided into two groups: emmetropes and myopes, with 55 participants in each group, is presented. The mean age was 21.78 ± 4.37 in emmetropes and 21.00 ± 2.78 in myopes. Among 55 emmetropes included in the study, 21 (38.2%) were male, and 34 (61.8%) were female, whereas among 55 myopes, 28 (50.9%) were male and 27 (49.1%) were female (Table 1).

Table 1: Demographics of Participants

Parameters	Emmetropes (n=55)	Myopes (n=55)
Age		
Mean ± SD	21.78 ± 4.37	21.00 ± 2.78
Gender		
Male	21 (38.2%)	28 (50.9%)
Female	34 (61.8%)	27 (49.1%)

Based on the level of refractive error, the myopic group was divided into two groups: mild and moderate. 40 participants, or around 72.8% of the myopic population sample, fell into the mild refractive error group, which included -0.50D to -2.75D. However, 15 individuals, or around 27.3% of the myopic population, showed a moderate degree of myopic refractive error (-3.00D to -6.00D). This data suggests a higher prevalence of mild myopic refractive error as compared to moderate in the study population (Figure 1).

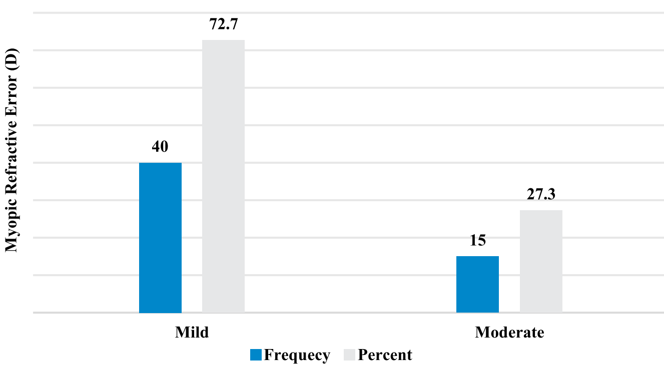

Figure 1: Distribution of Myopic Refractive Error Based on the Degree of Error

The Shapiro-Wilk test was employed to evaluate whether the data are normally distributed. The results of the normality test indicate that for both the near point of accommodation in emmetropes and myopes, the p-value was greater than 0.05, suggesting that the data were normally distributed. A repeated-measures ANOVA test was applied to compare the effect of green and blue filters on excessive accommodation. The mean ± standard deviation without filter, with green filter, and with blue filter in emmetropes was 14.89 ± 1.64, 12.07 ± 1.15, and 12.25 ± 1.03, respectively, with a significance of (p<0.001), suggesting that both green and blue filters reduce excessive accommodation in emmetropes, however no significance difference was found when the effect of both fiters were compared (p=0.190), although mean value of green showed superior effect (Table 2).

Table 2: NPA of Emmetropes with and Without Green and Blue Filters by Repeated Measure of ANOVA

Variables		Mean ± SD	Sig. (p-value)
NPA Without Filter vs with Green Filter	No Filter	14.890 ± 1.640	<0.001*
	Green Filter	12.072 ± 1.156	
NPA Without Filter vs with Blue Filter	No Filter	14.890 ± 1.640	<0.001*
	Blue Filter	12.254 ± 1.031	
NPA With Green Filter vs Blue Filters	Green Filter	12.072 ± 1.156	0.190
	Blue Filter	12.254 ± 1.031	

(*) indicates statistical significance at p≤0.05

The mean ± standard deviation without filter, with a green filter, and with a blue filter in myopes was 13.92±1.68, 11.92±0.58, and 12.53±0.55, respectively (p<0.001), suggesting that both green and blue filters contribute to a reduction in excessive accommodation. Furthermore, the green filter showed a superior effect to blue filters in relieving excessive accommodation among corrected myopes (Table 3).

Table 3: NPA Myopes with and without Green and Blue Filters by repeated measure of ANOVA

Variables		Mean ± SD	Sig. (p-value)
No Filter vs Green Filter	No Filter	13.927 ± 1.687	<0.001*
	Green Filter	11.927 ± 0.588	
No Filter vs Blue Filter	No Filter	13.927 ± 1.687	<0.001*
	Blue Filter	12.536 ± 0.559	
Green Filter vs Blue Filter	Green Filter	11.927 ± 0.588	<0.001*
	Blue Filter	12.536 ± 0.559	

(*) indicates statistical significance at p≤0.05

DISCUSSION

Filters function by blocking a certain region of the colour spectrum, thus greatly enhancing the remaining wavelengths of light. Coloured filters have been extensively utilized for the past fifteen years as a safe remedy for visual stress, and their effectiveness has been proven over time [17]. This study was carried out to assess the near-point of accommodation with green and blue filters in optically corrected myopic patients. Myopia is the most prevalent condition, affecting 2.9% of the global population and up to 52% of the school-age population. People 65 years of age and older have a 46% increased risk of developing myopia [18]. A previous study indicated that participants with an AC/A ratio of 5.84 or above were 22.5 times more likely to develop myopia within the next year (p<0.001) [19]. Thus, it was determined that the AC/A ratio was a significant risk factor for the onset of myopia [19]. To the best of our knowledge, no study was conducted in Pakistan that

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showed the effect of coloured filters on excessive accommodation, asthenopia symptoms, and eye fatigue. This study aimed to highlight the positive effect of coloured filters in this domain, which may result in the prevention and/or improvement of refractive error, strabismus, and other visual anomalies. A previous study was conducted in 2023 on the effect of green and red filters on high and low AC/A ratios among emmetropes. It was found that the mean ± SD of low AC/A was 3.48:1 Δ ±0.72 by using green filters, whereas the mean ± SD of high AC/A ratio was 5.57:1 Δ ±0.49 with green filters. It was found that both green and red filters significantly improved the AC/A ratio in emmetropes ($p<0.001$) [20]. In the current study, the near point of accommodation (NPA) with green and blue filters in optically corrected myopes as well as in emmetropes was assessed. It was found that in emmetropes, the mean ± SD without any filter, then using green and blue filters were 14.89 ± 1.64, 12.07 ± 1.15, and 12.25 ± 1.03, respectively. Whereas, in myopes, the mean ± standard deviation without filter, with green filter, and with blue filter was 13.92 ± 1.68, 11.92 ± 0.58, and 12.53 ± 0.55, respectively. The results were statistically significant with both green and blue filters ($p<0.001$). It was concluded that the excessive accommodation was relieved with both green and blue filters in optically corrected myopic patients and emmetropes. However, the green filter significantly improved excessive accommodation as compared to the blue filter in optically corrected myopic patients. The findings of this investigation corroborate a Simmers study that found increased ocular accommodation during near-target but decreased when using tinted lenses. This is because, in the absence of a lens, the target's total brightness is at its highest, producing the maximum amplitude of response [20]. Filters result in a dilation of the pupil, which happens naturally in reaction to a drop in light levels specific degree of pupillary dilation [17]. The lens flattens when the pupil dilates, resulting in a relaxation of accommodation. This study emphasizes the use of filters for more comfortable eyesight in optically corrected myopic patients.
The cross-sectional design of the study did not allow for evaluating long-term filter effects; the samples were restricted to mild-to-moderate myopes and high myopes, and other refractive errors were not included; possible confounding factors like digital screen usage and near work habits were not controlled. The longitudinal studies ought to determine the long-term impacts of using filters on accommodation and myopia progression. High myopes, hypermetropies, and astigmats should also be studied, and the effect of the filters on visual comfort and digital eye strain should be investigated both in the real-world environment.

CONCLUSIONS

It was concluded that the use of green and blue filters could decrease excessive near point of accommodation (NPA), thus proving that filters are an effective tool for managing eye strain, especially in today's digital world. Furthermore, the green filter showed a more significant effect than the blue filter on decreasing NPA in the myopes.

Authors' Contribution

Conceptualization: RBE, MMN
Methodology: SS, RBE, MMN, MA, TS, EI
Formal analysis: RBE, MMN
Writing and Drafting: SS, TS, EI
Review and Editing: SS, RBE, MMN, MA, TS, EI

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

All the authors declare no conflict of interest.

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