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Short-term effects of different wavelengths on axial length with induced optical defocus among emmetropes

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Purpose. *Mobile phone usage is widespread in the digital age, potentially affecting eye health. This study aims to evaluate the effect of mobile screen exposure to different wavelengths, along with induced myopic and hyperopic defocus.* ***Material and methods.*** *A pre- and post-test quasi-experimental research of 50 emmetropic undergraduate students with a mean age of 20.68 ± 0.98 years were performed at the Pakistan Institute of Ophthalmology, Al-Shifa Trust Eye Hospital, Rawalpindi, Punjab, Pakistan, utilizing non-probability judgmental sampling. Those without ocular or general health issues and no significant refractive error on retinoscopy were included. Axial length (AL) was measured using the IOL Master 800 after thorough eye and visual examinations. An Android mobile application "Flash Screen" exposed participants to violet, blue, yellow, white, green, and red light. Myopic defocus was induced using +3.00 D lenses and hyperopic defocus with -3.00 D lenses. Jaffery Amazing Statistical Package (JASP) analyzed data.* ***Results.*** *Baseline axial length (AL BL) was 23.235 ± 0.657 mm. AL changed significantly after exposure to violet, blue, yellow, white, green, and red light with and without induced myopic (MD) and hyperopic (HD) defocus. Significant AL decreases ($p < 0.001$) were seen under violet and blue light settings, with an effect size (ES) at 1.000. Under hyperopic defocus, green and red light revealed considerable alterations ($p < 0.001$), with significant negative impacts. Yellow light barely changed AL.* ***Conclusion.*** *Emmetropes exhibit AL changes to different wavelength as per longitudinal chromatic aberrations, and dominate optical defocus effect.*

Keywords: axial length; emmetropes; screen exposure; optical defocus; wavelengths
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Краткосрочные эффекты воздействия света с различной длиной волны и индуцированной оптической дефокусировки на осевую длину глаза у студентов с эмметропией

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Использование мобильных телефонов широко распространено в цифровую эпоху, что потенциально влияет на здоровье глаз. ***Цель*** *исследования — оценка воздействия различных длин волн экрана мобильного телефона, а также индуцированной миопической и гиперметропической дефокусировки на состояние глаз.* ***Материал и методы.*** *Предварительное и послетестовое квазиэкспериментальное исследование включало 50 студентов-эмметропов в возрасте 20,68 ± 0,98 года без нарушений со стороны глаз или общего состояния здоровья и без значительной рефракционной ошибки по данным ретиноскопии в Пакистанском институте офтальмологии, глазной больнице Al-Shifa Trust (Равалпинди) с использованием невероятностной оценочной выборки. Осевая длина глаза измерялась с помощью IOL Master 800 после тщательного офтальмологического обследования. Источником воздействия на орган зрения фиолетового, синего, желтого, белого, зеленого и красного света было мобильное приложение Android «Flash Screen». Миопическую дефокусировку вызывали с помощью линз +3,00 D, а гиперметропическую — с помощью линз -3,00 D. Данные были проанализированы с помощью пакета Jaffery Amazing Statistical Package (JASP).* ***Результаты.*** *Исходная длина передне-задней оси глаза (ПЗО), составлявшая 23,235 ± 0,657 мм, существенно менялась в ответ на экспозицию всех перечисленных цветов, как с наведением миопического и гиперметропического дефокуса, так и без него. Достоверное укорочение ПЗО отмечено под действием фиолетового и в меньшей степени голубого цвета (p < 0,001). Желтый цвет незначительно изменял ПЗО. Длинноволновый (зеленый и красный) свет вызывал удлинение ПЗО (p < 0,001), причем гиперметропический дефокус усиливал этот эффект.* ***Заключение.*** *У эмметропов длина ПЗО изменяется в ответ на воздействие света разной длины волны как результат продольной хроматической аберрации - спектрального дефокуса, который доминирует над оптическим дефокусом.*

Ключевые слова: длина передне-задней оси глаза; эмметропы; излучение экрана; оптический дефокус; длина волны
Конфликт интересов: отсутствует.
Прозрачность финансовой деятельности: никто из авторов не имеет финансовой заинтересованности в представленных материалах или методах.
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Light is the form of electromagnetic radiation [1]. Visible spectrum of light (380–740 nm) consist of different wavelengths, conventionally classified as shorter wavelength (380–495 nm), Medium wavelength (495–570) and longer wavelengths (590–750) [2]. Shorter wavelength (SL) includes violet and blue spectrum, medium wavelength includes green and yellow while longer wavelength orange and red [3]. Optically these wavelengths interact with eye biometric differently as per LCA (longitudinal chromatic aberrations) causes changes in axial length and ocular biometrics which in turn leads to refractive error either myopia (axial elongation) or hyperopia (axial shortening) [4, 5]. Optical defocus is a form of aberrations in which the rays of light either focus in front of the retina (Myopic Defocus) or back of the retina (Hyperopic Defocus) placing a convex or concave lenses respectively. Optical defocus also causes changes in axial length with myopic defocus causes axial shortening while hyperopic defocus causes axial elongations [6]. Many experimental model on animals demonstrate the effect of different light spectrum on axial length like shorter wavelength (blue or violet light) causes axial shortening in chicks [7], mice [8, 9] and guinea pigs [10], however conflicting evidence seen in tree shrew [11], in which exposure to these wavelength causes axial elongation. Likewise, longer wavelengths exposure to chicks [12], tree shrew [13], guinea pigs [14, 15] and fishes [16] causes axial elongation, but causes axial shortening in rhesus monkeys [17] and tree shrew [13, 18]. Few humans [4] study exist in the literature on the effect of different spectrum of light on axial length (AL) and optical defocus especially on the combine effect.

To investigate the effect of various light spectra on AL, both independently and in conjunction with myopic and hyperopic defocus, a study was conducted. The theory suggests that myopic shift among myopes results from non-exertion of accommodation, while accommodative lag occurs due to excessive near work. The study explored whether LCA influences AL changes. Specifically, it hypothesized that myopic defocus with shorter wavelength exposure would lead to greater axial shortening, whereas hyperopic defocus with longer wavelength exposure would cause more axial elongation.

PURPOSE: this study aimed to determine the effect of different wavelengths, combined with myopic and hyperopic defocus, on AL among emmetropes.

MATERIAL AND METHODS

A quasi-experimental study (pre- and post-test) was carried out at the Pakistan Institute of Ophthalmology, Al-Shifa Trust Eye Hospital in Rawalpindi, Punjab, Pakistan. The study took place over 1.5 years, from January 2023 to June 2024. A sample size of 50 was determined using G*Power Software (version 3.1.9.4) by calculating an α of 5% (0.05), Power (1-β error probability), and effect size of 0.5 (medium effect) with a two-tailed hypothesis. To compare dependent means after interventions such as optical defocus and different wavelength exposure among emmetropes, a sample size of 45 was calculated, with an additional 10% for non-compliance. All participants were recruited using a non-probability judgmental sampling technique. The participants included emmetropes, with no significant refractive error and a spherical equivalent refraction of at least +0.50 D or less. Exclusions were made for subjects with ocular diseases, ocular trauma or surgery history, and systemic illnesses such as diabetes mellitus (DM), hypertension (HTN), and obesity. Additionally, participants with a history of using drugs like steroids, sulfa drugs, or prostaglandin analogs, either topically or systemically, were excluded.

All participants underwent thorough eye and visual examinations, including detailed medical histories. Eye examinations were conducted using slit-lamp biomicroscopy for the anterior and posterior segments. Visual acuity was measured using standard Log-MAR charts, and refractive status was determined using an auto-refractometer cross-checked with retinoscopy, which is considered the gold standard technique. Participants were instructed to focus on distant objects to reduce the effects of previous visual activities. Baseline measurements were taken using the IOL Master model 800 while participants were seated in a dark room. They were then exposed to different wavelengths of light using an Android mobile application called "Flash Screen" on a Samsung mobile screen with a 5.6-inch display placed at a distance of 40 cm for 5 minutes. Three readings were taken, and the average was recorded. The following day, participants were exposed to the same wavelength with myopic defocus in front of the right eye for 5 minutes, and AL measurements were taken using the IOL Master. On the third day, participants were exposed to the same wavelength with hyperopic defocus in front of the right eye. On subsequent days, participants were exposed to blue, yellow, white, green, and red wavelengths alone and with myopic and hyperopic defocus, and measurements were recorded. During the experiment, participants abstained from consuming caffeine, including tea, coffee, and other caffeinated beverages, to minimize the potential effects on axial length. All interventions and examinations were conducted between 9 am and 12 pm according to Pakistan Standard Time to minimize the influence of diurnal variation on AL.

We received ethical approval from the Ethical Review Committee (ERC) of the Al-Shifa Research Center (ASRC) with the reference No: ERC-10/AST-24. Additionally, the study was registered with the Center of Postgraduate Studies (CPGS) at Lincoln University College, Malaysia. We obtained fully informed consent from all study participants in accordance with the Helsinki Declaration. Participants were guaranteed the confidentiality of their data. Data from the proforma was entered into the Jaffery Amazing Statistical Package (JASP). We calculated frequency distribution and descriptive statistics for variables such as age, gender, and AL both at baseline and after exposure to different wavelengths and combinations with myopic and hyperopic defocus. To conduct inferential statistics, we checked for normality using the Kolmogorov-Smirnov test, which indicated a non-normal distribution. Therefore, we applied the Wilcoxon signed-rank test to compare baseline AL with different wavelengths and optical defocus combinations. We used Raincloud difference plots to illustrate differences after each intervention from the baseline. We considered statistical significance at 5% or less.

RESULTS

Table 1 presents the clinico-demographic characteristics of 50 study participants, including mean age and gender-specific age distributions, visual acuity (VA) measurements in Log-MAR for both eyes, and refractive parameters such as spherical and cylindrical refraction, axis, and spherical equivalent refraction (SER). The mean age of participants is 20.680 years, with minor differences between males and females. Visual acuity and refractive measurements show low variation, indicating a homogeneous sample. The data are presented with standard errors and 95% confidence intervals to illustrate the precision of the estimates.

Table 2 summarizes the descriptive statistics for the AL of participants' eyes at baseline and after exposure to various wavelengths of light, with and without induced myopic (MD) and hyperopic defocus (HD). The data are presented as means with standard deviations (Mean ± SD), standard errors of the mean (SEM), 95% confidence intervals (CI), and ranges. Each wavelength condition also includes measurements with induced myopic (MD) and hyperopic defocus (HD), showing slight variations in axial length. The 95% confidence intervals indicate the precision of these mean estimates, with standard errors ranging from 0.066 to 0.097 mm and ranges around 2.7 mm for all conditions.

Table 3 presents the statistical comparisons between baseline AL (AL BL) and AL measurements after exposure to various wavelengths of light (Violet, Blue, Yellow, White, Green, Red), with and without induced myopic (MD) and hyperopic defocus (HD). The results include the Wilcoxon signed-rank test (W), test statistic (z), p-values (p), rank-biserial correlation coefficients, and their standard errors (SE). Significant changes in AL under different lighting conditions, indicating how various wavelengths

Table 1. Demographic and Clinical Profile of Study Participants
Таблица 1. Демографические и клинические характеристики участников исследования

			95% Confidence Interval Mean 95%-ный доверительный интервал		
n = 50	mean среднее	std. se of mean	upper верхнее	lower нижнее	range диапазон
Age, years Возраст, лет	20.680 ± 0.978	0.138	20.958	20.402	4.000
Males Муж	20.800 ± 0.862	0.223	21.277	20.323	3.000
Females Жен	20.629 ± 1.031	0.174	20.983	20.274	4.000
VA OD Log MAR ОЗ OD Log MAR	-0.026 ± 0.044	0.006	-0.013	-0.039	0.100
VA OS Log-MAR ОЗ OS Log-MA	-0.030 ± 0.046	0.007	-0.017	-0.043	0.100
Sph OD	0.112 ± 0.158	0.022	0.157	0.067	0.500
Sph OS	0.112 ± 0.158	0.022	0.157	0.067	0.500
Cyl OD	-1.877 ± 6.137	0.868	-0.133	-3.621	25.000
Cyl OS	-1.887 ± 6.134	0.868	-0.144	-3.631	25.000
Axis OD	70.300 ± 86.091	12.175	94.767	45.833	180.000
Axis OS	73.800 ± 86.729	12.265	98.448	49.152	180.000
SER СЭР OD	1.019 ± 4.948	0.700	2.425	-0.388	25.250
SER СЭР OS	1.014 ± 4.949	0.700	2.420	-0.393	25.250

Note. std — standard, SD — Standard deviation, VA — Visual Acuity, OD — Right Eye, OS — Left Eye, Log-MAR — Logarithm of Minimum Angle of Resolution, SER — Spherical Equivalent Refraction.
Примечание. std — стандарт, SD — стандартное отклонение, ОЗ — острота зрения, OD — правый глаз, OS — левый глаз, Log-MAR — логарифм минимального угла разрешения, СЭР — сферический эквивалент рефракции.

Table 2. Descriptive statistics of baseline axial length and changes after exposure to different wavelengths of light with induced optical defocus
Таблица 2. Описательная статистика значений исходной длины глаза и ее изменений после воздействия света с различной длиной волны и индуцированной оптической дефокусировкой

			95% Confidence Interval Mean 95%-ный доверительный интервал		
n=100 (eyes, глаз)	Mean ± SD	std. se of mean	upper верхнее	lower нижнее	range диапазон
AL BL ПЗО исх.	23.235 ± 0.657	0.066	23.365	23.104	2.720
AL VL ПЗО ФС	23.213 ± 0.659	0.066	23.344	23.082	2.750
AL VL MD ПЗО ФС МД	23.198 ± 0.658	0.066	23.328	23.067	2.760
AL VL HD ПЗО ФС ГД	23.205 ± 0.657	0.066	23.335	23.074	2.780
AL BLT ПЗО СС	23.207 ± 0.657	0.066	23.338	23.077	2.740
AL BLT MD ПЗО СС МД	23.192 ± 0.657	0.066	23.322	23.061	2.760
AL BLT HD ПЗО СС ГД	23.197 ± 0.657	0.066	23.328	23.067	2.790
AL YL ПЗО ЖС	23.187 ± 0.657	0.097	23.382	23.067	2.790
AL YL ПЗО ЖС МД	23.190 ± 0.686	0.097	23.384	22.995	2.740
AL YL HD ПЗО ЖС ГД	23.191 ± 0.683	0.097	23.385	22.996	2.720
AL WL ПЗО БС	23.190 ± 0.686	0.097	23.386	23.995	2.770
AL WL MD ПЗО БС МД	23.190 ± 0.657	0.097	23.385	22.995	2.740
AL WL HD ПЗО БС ГД	23.189 ± 0.685	0.097	23.383	22.994	2.720
AL GL ПЗО ЗС	23.240 ± 0.658	0.066	23.371	23.110	2.720
AL GL MD ПЗО ЗС МД	23.236 ± 0.658	0.066	23.366	23.105	2.730
AL GL HD ПЗО ЗС ГД	23.250 ± 0.658	0.066	23.380	23.119	2.730
AL RL ПЗО КС	23.246 ± 0.656	0.066	23.376	23.116	2.720
AL RL MD ПЗО КС МД	23.243 ± 0.656	0.066	23.373	23.113	2.710
AL RL HD ПЗО КС ГД	23.258 ± 0.657	0.066	23.388	23.128	2.720

Note. std. — standard, SD — Standard Deviation, SE — Standard Error, AL — Axial length, BL — baseline, VL — Violet Light, MD — Myopic Defocus, HD — Hyperopic Defocus, BLT — Blue Light, YL — Yellow Light, WL — White Light, GL — Green Light, RL — Red Light.
Примечание. std — стандарт, SD — стандартное отклонение, SE — средняя ошибка, ПЗО — передне-задняя ось глаза, ФС — фиолетовый свет, МД — миопический дефокус, ГД — гиперметропический дефокус, СС — синий свет, ЖС — желтый свет, БС — белый свет, ЗС — зеленый свет, КС — красный свет.

of light, along with induced defocus, impact AL. This table compares AL BL with AL measurements under different light conditions (Violet, Blue, Yellow, White, Green, Red) and with induced optical defocus (myopic and hyperopic). The Wilcoxon signed-rank test shows significant differences ($p < .001$) in most conditions, especially for Violet, Blue, Green, and Red light, both with and without defocus. Rank-biserial correlations indicate strong effects, particularly for Violet and Blue light conditions. Yellow light did not show significant changes, while White light had a moderate effect.

DISCUSSION

The present study provides baselines findings of the short-term effect of light of different wavelength from mobile application, combined with myopic and hyperopic defocus, on Al of emmetropes (Fig. 1–3). Significant changes in AL occur in response to different wavelengths and with myopic and hyperopic defocus, which revealed spectral role of managing refractive error in the digital era.

The findings demonstrate that shorter wavelengths (blue and violet wavelength) significantly causes AL shortening indicating with the role of the spectral composition of light in the management of refractive errors [4]. From the effect sizes of both these same spectra, shorter wavelengths violet has stronger effect as compared to blue in term of axial shortening, revealed that shorter the wavelength the more AL shortening occurred. These findings are consistent as reported by H. Torii et al, 2022 [19]. The suppression of myopia progression by violet light (VL) is facilitated through

Table 3. Statistical Comparisons of Axial Length at Baseline and After Exposure to Different Wavelengths of Light with Induced Optical Defocus
Таблица 3. Статистические сравнения исходной длины ПЗО и после воздействия света с различной длиной волны с индуцированной оптической дефокусировкой

Baselines AL ПЗО исх.	AL after intervention ПЗО после воздействия	W	z	p	Rank-Biserial Correlation Ранговая бисериальная корреляция	SE Rank-Biserial Correlation SE Ранговая бисериальная корреляция
Violet light exposure & Optical defocus (Myopic & Hyperopic) Воздействие ФС и оптической дефокусировки (миопической и гиперметропической)						
AL BL ПЗО исх.	AL VL ПЗО ФС	4095.000	8.239	< 0.001	1.000	0.121
	AL VL MD ПЗО ФС МД	5050.000	8.682	< 0.001	1.000	0.115
	AL VL HD ПЗО ФС	4549.000	8.422	< 0.001	0.995	0.118
Blue light exposure & Optical defocus (Myopic & Hyperopic) Воздействие ГС и оптической дефокусировки (миопической и гиперметропической)						
AL BL ПЗО исх.	AL BLT ПЗО СС	4656.000	8.507	< 0.001	1.000	0.117
	AL BLT MD ПЗО СС МД	5050.000	8.682	< 0.001	1.000	0.115
	AL BLT HD ПЗО СС ГД	4746.500	8.528	< 0.001	0.997	0.116
Yellow light exposure & Optical defocus (Myopic & Hyperopic) Воздействие ЖС и оптической дефокусировки (миопической и гиперметропической)						
AL BL ПЗО исх.	AL YL ПЗО ЖС	83.500	0.801	0.214	0.228	0.277
	AL YL MD ПЗО ЖС МД	84.000	-0.784	0.791	-0.200	0.250
	AL YL HD ПЗО ЖС ГД	80.500	-1.986	0.980	-0.463	0.229
White light exposure & Optical defocus (Myopic & Hyperopic) Воздействие БС и оптической дефокусировки (миопической и гиперметропической)						
AL BL ПЗО исх.	AL WL ПЗО БС	67.000	-2.570	0.996	-0.588	0.225
	AL WL MD ПЗО БС МД	86.500	-1.299	0.911	-0.316	0.239
	SFCT WL HD СФТХ БС ГД	0.000	-8.682	1.000	-1.000	0.115
Green light exposure & Optical defocus (Myopic & Hyperopic) Воздействие ЗС и оптической дефокусировки (миопической и гиперметропической)						
AL BL ПЗО исх.	AL GL	216.500	-5.845	< 0.001	-0.815	0.139
	AL GL MD	592.000	-0.883	0.367	-0.141	0.158
	AL GL HD	63.000	-8.181	< 0.001	-0.972	0.118
Red light exposure & Optical defocus (Myopic & Hyperopic) Воздействие КС и оптической дефокусировки (миопической и гиперметропической)						
AL BL ПЗО исх.	AL RL ПЗО КС	83.500	-6.905	1.000	-0.936	0.135
	AL RL MD ПЗО КС МД	442.000	-4.467	1.000	-0.623	0.139
	AL RL HD ПЗО КС ГД	87.000	-7.990	1.000	-0.959	0.119

Note. std. — standard, SD — Standard Deviation, SE — Standard Error, W — Wilcoxon signed-rank test, z — test statistic, AL — Axial length, BL — baseline, VL — Violet Light, MD — Myopic Defocus, HD — Hyperopic Defocus, BLT — Blue Light, YL — Yellow Light, WL — White Light, GL — Green Light, RL — Red Light, SFCT — Subfoveal Choroidal Thickness.
Примечание. std. — стандарт, SD — стандартное отклонение, SE — стандартная ошибка, W — критерий знаковых рангов Вилкоксона, z — статистика теста, AL — длина ПЗО, ФС — фиолетовый свет, МД — миопический дефокус, ГD — гиперметропический дефокус, СС — синий свет, ЖС — желтый свет, БС — белый свет, ЗС — зеленый свет, КС — красный свет, СФТХ — субфовеолярная толщина хориоидеи.

the maintenance of choroidal thickness by OPN5 in the retina. OPN5, a VL-sensitive opsin photoreceptor [20, 21]. It was also evident from the literature that the myopia protective role of sunlight is due to the predominance of the presence of shorter wavelength [7]. Also some school of thought claim for the shorter wavelength filtering role of the conventional spectacles lenses and glass of windows and doors which in turn leads to myopia and axial elongation [7].

The results of longer wavelength (Red and Green) also revealed significant axial elongation with more obvious alteration with hyperopic defocus, indicating that longer wavelength causes axial elongation, but hyperopic defocus enhances its

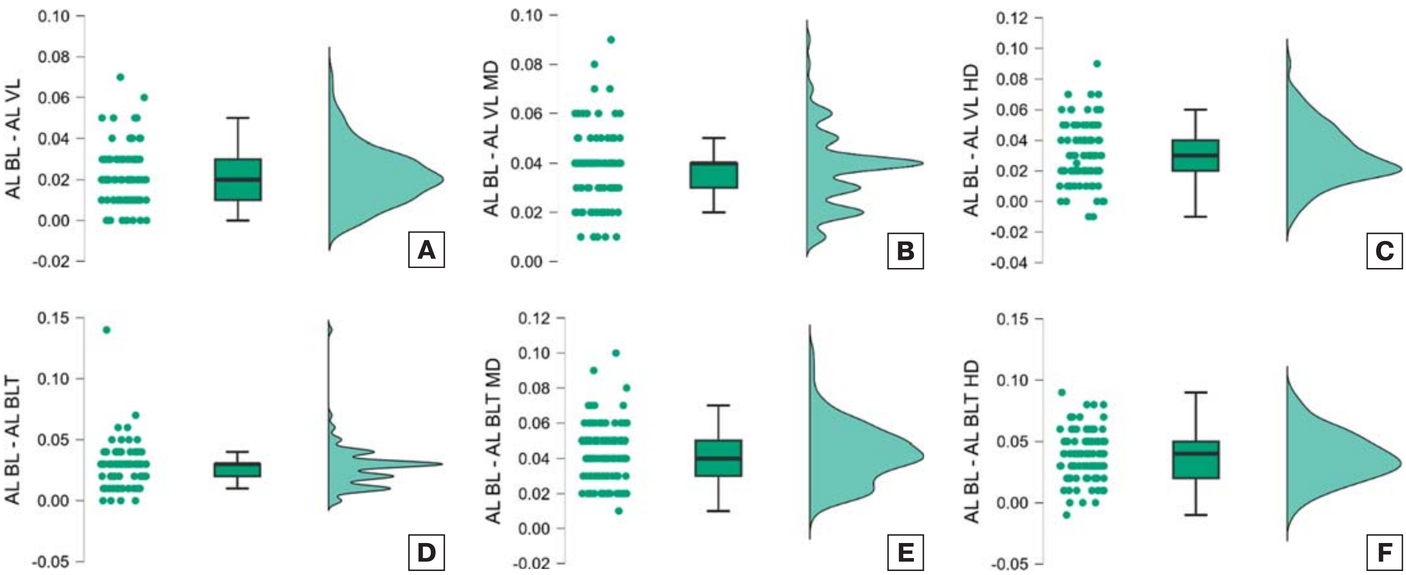

Fig. 1. A, B, C — depict AL changes from baseline to violet light exposure, followed by subsequent combined exposure to violet light with myopic defocus and hyperopic defocus. D, E, F — depict AL changes from baseline to blue light exposure, followed by subsequent combined exposure to blue light with myopic defocus and hyperopic defocus

Рис. 1. A, B, C — изменения исходной длины ПЗО в результате воздействия фиолетового света, а также последующего комбинированного воздействия фиолетового света, миопической и гиперметропической дефокусировки. D, E, F — изменения исходной длины ПЗО в результате воздействия синего света, а также последующего комбинированного воздействия синего света, миопической и гиперметропической дефокусировки

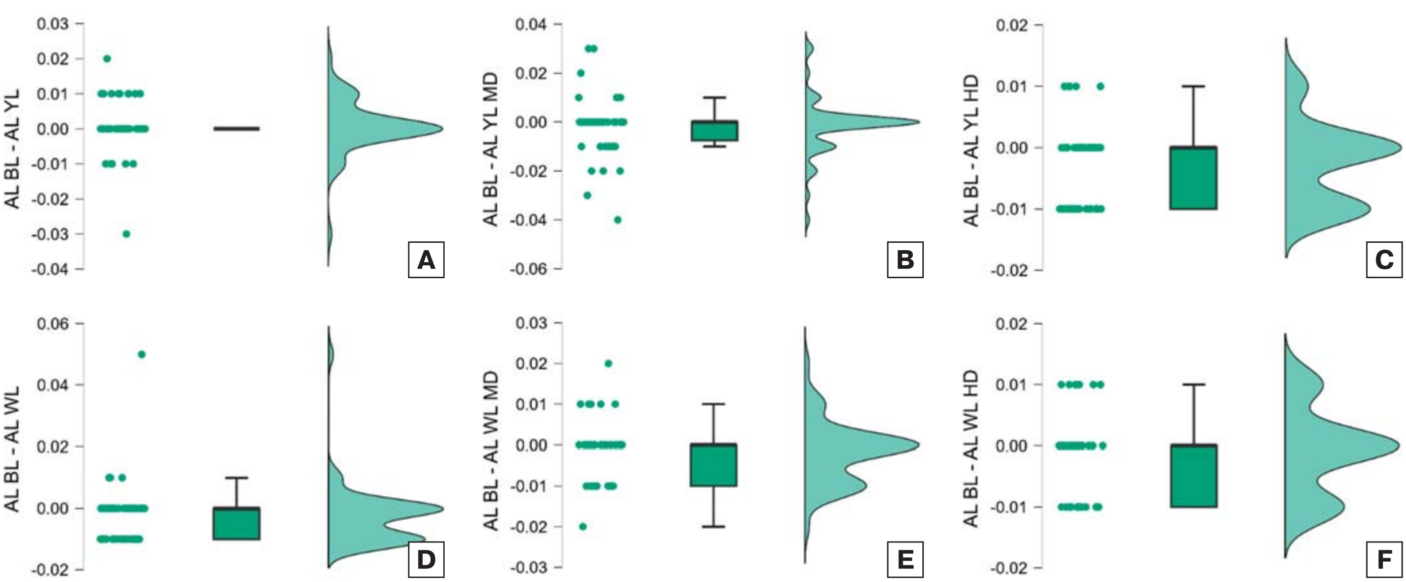

Fig. 2. A, B, C — depict AL changes from baseline to yellow light exposure, followed by subsequent combined exposure to yellow light with myopic defocus and hyperopic defocus. D, E, F — depict AL changes from baseline to white light exposure, followed by subsequent combined exposure to white light with myopic defocus and hyperopic defocus

Рис. 2. A, B, C — изменения исходной длины ПЗО в результате воздействия желтого света, а также последующего комбинированного воздействия желтого света, миопической и гиперметропической дефокусировки. D, E, F — изменения исходной длины ПЗО в результате воздействия белого света, а также последующего комбинированного воздействия белого света, миопической и гиперметропической дефокусировки

effect, indicating hyperopic defocus role along with longer wavelengths. These findings are also consistent with literature as reported by S. Thakur et al. [4]. The mechanism for this axial elongation is due to Longitudinal Chromatic Aberration (LCA) with the presence of hyperopic defocus enhances while myopic defocus suppresses [22, 23].

Results from the yellow and full white mobile screen exposure show statistically insignificant changes, which is evident form literature [4], that the medium wavelengths have less significant role in alteration of AL, however small but statistically significant difference were observed, when in conjunction with myopic and hyperopic defocus, indicating again the role spectral as well as optical defocus.

The strengths of the present study are that it is one of the few studies examining different spectral exposures on human subjects. Additionally, it is the only study to use a mobile phone application

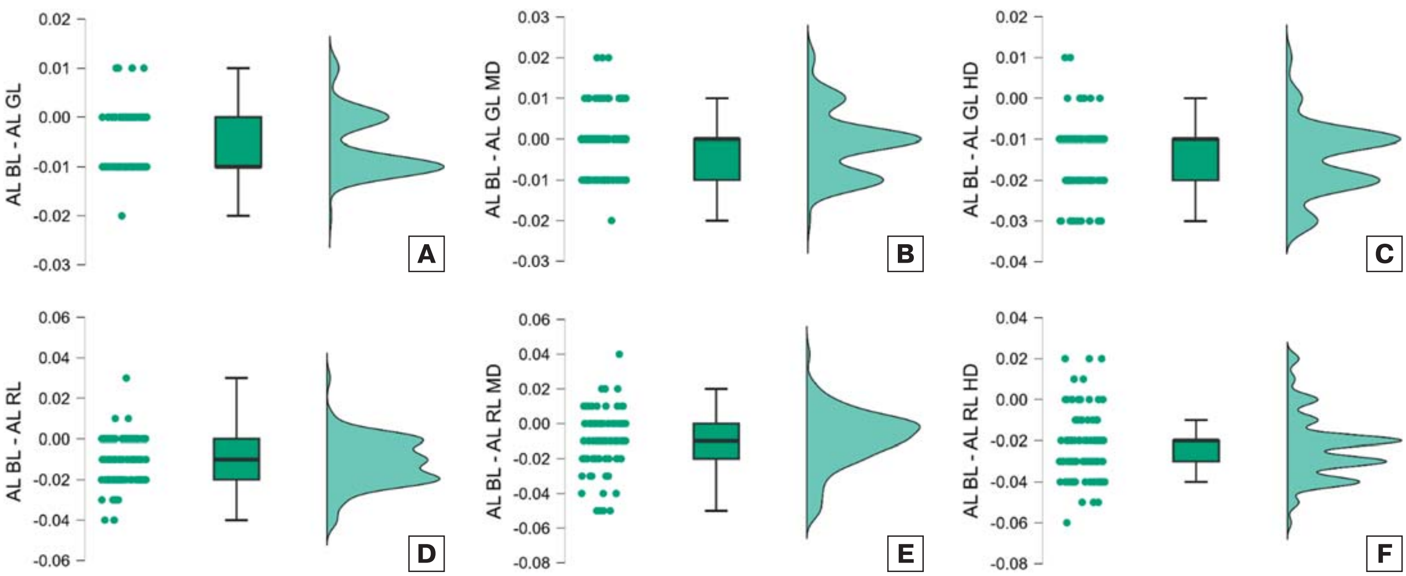

Fig. 3. A, B, C — depict AL changes from baseline to yellow light exposure, followed by subsequent combined exposure to yellow light with myopic defocus and hyperopic defocus. D, E, F — depict AL changes from baseline to white light exposure, followed by subsequent combined exposure to white light with myopic defocus and hyperopic defocus

Рис. 3. A, B, C — изменения исходной длины ПЗО в результате воздействия желтого света, а также последующего комбинированного воздействия желтого света, миопической и гиперметропической дефокусировки. D, E, F — изменения исходной длины ПЗО в результате воздействия белого света, а также последующего комбинированного воздействия белого света, миопической и гиперметропической дефокусировки

for light exposure of different wavelengths, which is more practical compared to previously reported studies that used a controlled experimental environment. Although the present study's findings have a significant role on management of refractive error from the different spectrum of light, the study has limitations too. Peripheral refraction (peripheral hyperopic defocus), which has a role in myopia progression, was not assessed during different exposure of these wavelengths. The long-term exposure, and effect of these wavelengths, were another limitation. Future studies should be conducted among myopic and hypermetropic subjects, to explore that these spectral and optical defocus intervention effect on AL and ocular biometrics and comparison with emmetropes could give the evidence of exhibition of same behavior of ametropic eyes to different wavelengths and in conjunction with optical defocus.

CONCLUSION

Emmetropes exhibits AL changes to different wavelengths, as per longitudinal chromatic aberration, with axial elongation to longer wavelength exposure and axial shortening to shorter wavelength exposure with little or no variation to medium wavelengths. Moreover, when combined with myopic and hyperopic defocus, the spectral effect dominates over the optical effect.

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