ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

Short Term Effect of Blue Light Filter on Veregnce, Accommodation and Visual Comfort in Digital Task Using Laptop

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Publication Date: 2026/02/06

How to Cite: Bachan Chaudhary; Bishal Bhujel; A. P. Nishad Begum (2026) Short Term Effect of Blue Light Filter on Veregnce, Accommodation and Visual Comfort in Digital Task Using Laptop. *International Journal of Innovative Science and Research Technology*, 11(1), 2988-3036. https://doi.org/10.38124/ijisrt/26jan384

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

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ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

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ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CERTIFICATION

A dissertation submitted in partial fulfillment for award of degree of

Bachelor in Science of Optometry

Rajiv Gandhi University of Health Sciences, Karnataka, Bangalore.

2021-2025

By

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ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

ACKNOWLEDGEMENT

Words are seldom sufficient to express our gratitude and feelings it still gives me an immense pleasure to acknowledge those who helped us during the tenure of my study. First and foremost, I thank the almighty for his guidance, grace and support.

Foremost, We would like to express our sincere gratitude to RAJIV GANDHI UNIVERSITY OF HEALTH SCIENCES for providing us this opportunity to carry out the research study as a partial fulfilment of B.Sc. Optometry.

Next we would like to express our sincere gratitude to the Principal, Dr. KRISHNA M.C and professor Dr. LAVANYA RAMAN (Department of Ophthalmology) for helping us grasp more knowledge about research.

We would like to express our boundless gratitude to our guide Mrs. NISHAD BEGUM for guiding us throughout this research work. We are incredibly grateful for her patience, time, and mentorship throughout this project. With her own passion for research that were important to us. We would also extend our gratitude to Ms. MUSKAN KOUSAR and all other faculty of Shridevi Institute of Allied Health Science who worked actively to provide us motivation to complete our project.

Our profound appreciation to Dr. RAJANI .A.P.(Department of Community medicine) for her expert guidance, analytical insights, and valuable assistance in the statistical aspects of this project.Her expertise greatly contributed to the accuracy and reliability of the results.

We also thank all the students who have participated in our study for their co-operation and sincerity towards the current study.

Last but not the least, we are deeply indebted to our family members , especially our parents, who gave us the encouragement we needed throughout this process. We would also like to thank all our friends for their support and help throughout this project.

Thank you very much, everyone!!

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

LIST OF ABBREVATIONS USED

- D - Diopter
- VA - Visual Acuity
- LOGMAR Chart -Logarithm Measure of Angle of Resolution Chart
- U/A - Unaided
- OD - Oculus Dexter
- OS - Oculus sinister
- OU - Oculus Uterque
- BLFL - Blue Light Filter Lens
- RAF Ruler - Royal Air Force Ruler
- NPA - Near Point Of Accommodation
- AF - Accommodative Facility
- NPC - Near point of Convergence
- VF - Vergence Facility
- AC/A Ratio - Accommodative Convergence/ Accommodation Ratio
- CM- Centimeter
- CPM - Cycle per Minute
- IPD- Interpupillary Distance
- ΔD - Prism diopter
- ARMD - Age-related macular degeneration
- DO- Direct ophthalmology
- P- Near point
- R- Far point

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

ABSTRACT

➢ ***Background:***

The increasing use of laptops and other digital devices has led to visual discomfort and fatigue due to prolonged near work, involving accommodation and vergence stress. Blue light from screens is believed to contribute to digital eye strain, and blue light filtering lenses are widely marketed to improve visual comfort.

➢ ***Objective:***

To assess and compare the acute effect of blue light filters on vergence (NPC, VF, AC/A), accomodation parameters (NPA, AF) and visual comfort after using laptop for 1 hour.

➢ ***Methodology:***

All participant underwent a preliminary workup that included distance and near visual acuity at 6 meters and 40 cm, respectively, which were measured using a logarithmic of the minimum angle of resolution (LogMAR) chart.Individuals with distance visual acuity equal to or better than 6/6 and near vision N6 were included in the study. Subjects with a history of ocular or systemic disease, spectacle, and/or contact lens wearers or those using any BL protection products were excluded.

After this,for baseline the NPA is measured both monocularly (direct) and binocularly (indirect).Then AF is measured using ±2.00D flippers. Also NPC is measured using linear target and VF using flippers with 12D BO & 3D BI Prism. Here AC/A ratio is calculated using heterophoric method. The brightness is adjusted using luxmeter with no any night mode on.

After baseline data, now participant is given a laptop for 1 hour to watch video same procedure conducted under two condition; with and without blue light filters,with two trails separated by a period of 24 hours.On first day,no filter was used ,while blue light filter was used on next day.Along with this 16 questionnaire developed by Aaras et. al, is also asked for the participant to know their visual comfort(graded from 0-2).

➢ ***Result:***

Across 48 young adults (23 males, 25 females), most visual parameters remained within normal ranges. NPA showed no significant change for OD ($p = 0.085$) and OU ($p = 0.279$), but a small significant improvement was found in OS ($p = 0.038$), indicating only the left eye responded to BLF use. Accommodative facility (AF) improved greatly for all conditions—OD, OS, and OU (all $p < 0.001$)—with binocular AF increasing from 12.56 to 13.87 cpm, showing faster focusing ability with BLF. NPC values showed minimal changes: Break increased slightly from 6.04 to 6.10 cm and Recovery from 9.38 to 9.47 cm, both statistically significant ($p = 0.046$ and $p = 0.006$) but not clinically meaningful, indicating almost unchanged convergence performance. Vergence facility (VF) improved from 15.16 to 15.91 cpm with BLF ($p < 0.001$), showing better binocular flexibility, though the effect size is small.The AC/A ratio remained unchanged at 0.25 under all conditions ($p = 0.42$ and $p = 0.31$), confirming that BLF has no effect on the accommodative–vergence interaction. Symptoms like burning, tearing, eye pain, dryness and headache were significantly reduced after using the BLFLs while using digital devices. Others symtoms also shows minimal effect after using BLFLs than compared without BLFLs use.

➢ ***Conclusion:***

This study demonstrates that short-term use of blue light filter lenses (BLFL) during laptop-based tasks leads to measurable improvements in visual function. A modest enhancement in accommodative parameters and slight improvement in vergence performance indicate reduced visual load when blue-light exposure is minimized. Participants also reported a clear reduction in visual discomfort, showing that BLFL lessen acute digital eye strain. Overall, BLFL act as an effective, non-invasive optical aid that supports more stable accommodative and binocular responses while improving visual comfort during short-duration laptop use.

Keywords: *Accommodation, Vergence, Visual Comfort, Blue Light, AC/A Ratio, Blue Light Filter Lens, Digital Task.*

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

TABLE OF CONTENTS

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

LIST OF TABLES

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

LIST OF FIGURES

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER ONE
INTRODUCTION

➢ *Introduction*

- *Blue Lights:*

Blue light is the short-wavelength electromagnetic radiation (400-500nm) in the visible spectrum (400-780nm) that carries the highest amount of energy per photon.(1)

The sun and artificial light sources, including LED (light emitting diode) light bulbs and fluorescent light tubes are primary sources of blue light. Blue light (BL) is a characteristic of digital devices such as tablets, computers and smartphone.With the increasing popularity of blue rich LED-backlight display devices,our eyes are exposed to more blue light than in the past.(2) The BL emmitted by the screen may improve several aspects of cognitive performance, such as alertness, sustained attention, working memory and declaration memory.[1] American screen time has been recorded at an average of just over 7.5 h/day.(3)

- *Blue Light Filterings:*

Various BL filtering techniques are designed to block the amount of BL entering the eyes during screen viewing. BLFLs are sold commercially with claims to protect the eye from the harmful effect of blue light, such as improve sleep at night and protect the retina against ARMD. There are BL filters, blocking lenses, and BL filtering intraocular lenses that have been widely used. BL emissions from computer screens may be decreased by BL filters by adding a physical filter, changing the display from white mode to night mode, or using a BL filter application (app).Depending upon the material and characterisctics of the blue light filter lens it blocks the amount of blue light entering into the eyes by upto 95%.[2,4]

Because BFLs attenuate light, reduced object contrast, which may impact visual behaviours such as perception of object speed which reduce then contrast.[4] While excessive blue light is theoretically harmful, adequate blue light is necessary for normal visual function. For example, blue light plays an important role in colour discrimination and night vision.

➢ *Accomodation*

Accommodation is the mechanism by which we can even focus the diverging rays coming from a near object on the retina in a bid to see clearly. In it, there occurs increase in the power of crystalline lens due to the change in shape of the lens resulting from a contraction of ciliary muscle. [5]

- Pupillary response and accommodation are important physiological processes of the eye that affect vision.[6]
- Ocular accommodation is a blur reflex and results in focusing of images onto the retina.[6]
- Other visual functions such as contrast sensitivity, colour perception and visual acuity are influenced by pupil size and accommodation.[6]
- The accommodative state is largely controlled by parasympathetic innervation of the culinary muscles, although sympathetic innervation plays a complementary role in relaxing accommodation.[6]

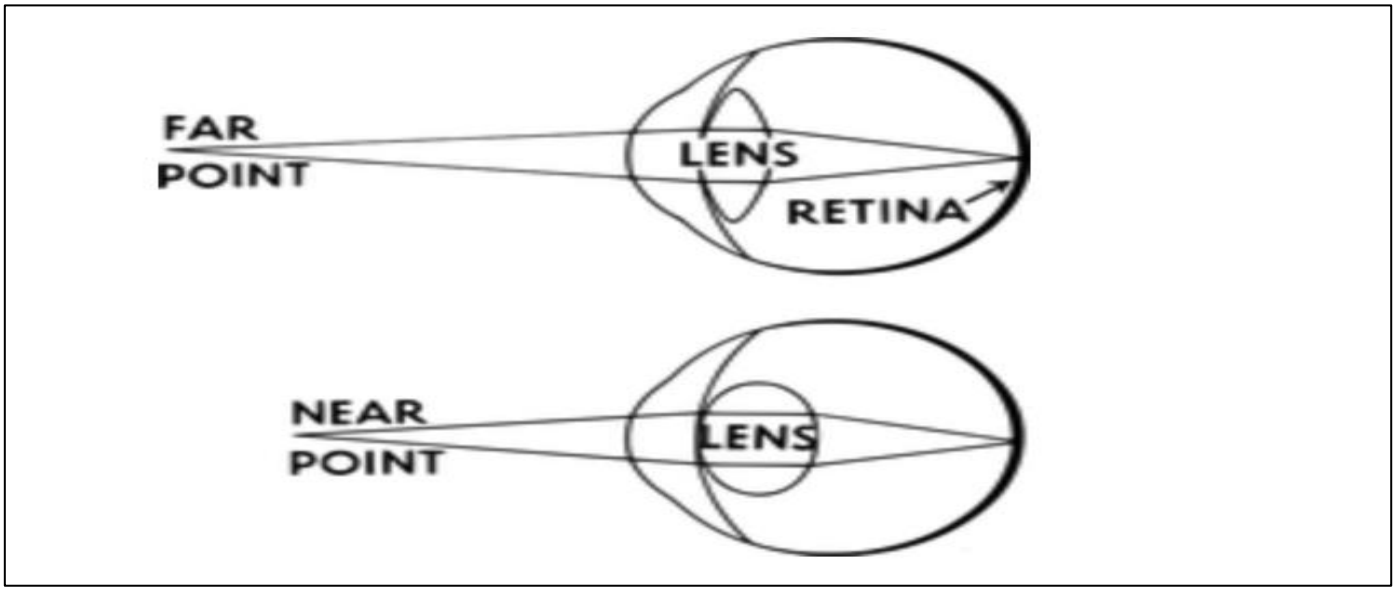

Fig 1 Physiology of Accommodation on Divergent Rays Entering the Eye
https://www.accuvision.co.uk/glossary/eye-accommodation/

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

➢ *Mechanism of Accommodation*

According to von Helmholtz's capsular theory the process of accommodation is achieved by a change in the shape of lens as below:[6]

When the eye is at rest (un-accommodated), the ciliary ring is large and keeps the zonules tense. Because of zonular tension the lens is kept compressed (flat) by the capsule.[6]

Contraction of the ciliary muscle causes the ciliary ring to shorten and thus releases zonular tension on the lens capsule.[6] This allows the elastic capsule to act unrestrained to deform the lens substance.[6] The lens then alters its shape to become more convex or conoidal (to be more precise).[6] The lens assumes conoidal shape due to configuration of the anterior lens capsule which is thinner at the centre and thicker at the periphery.

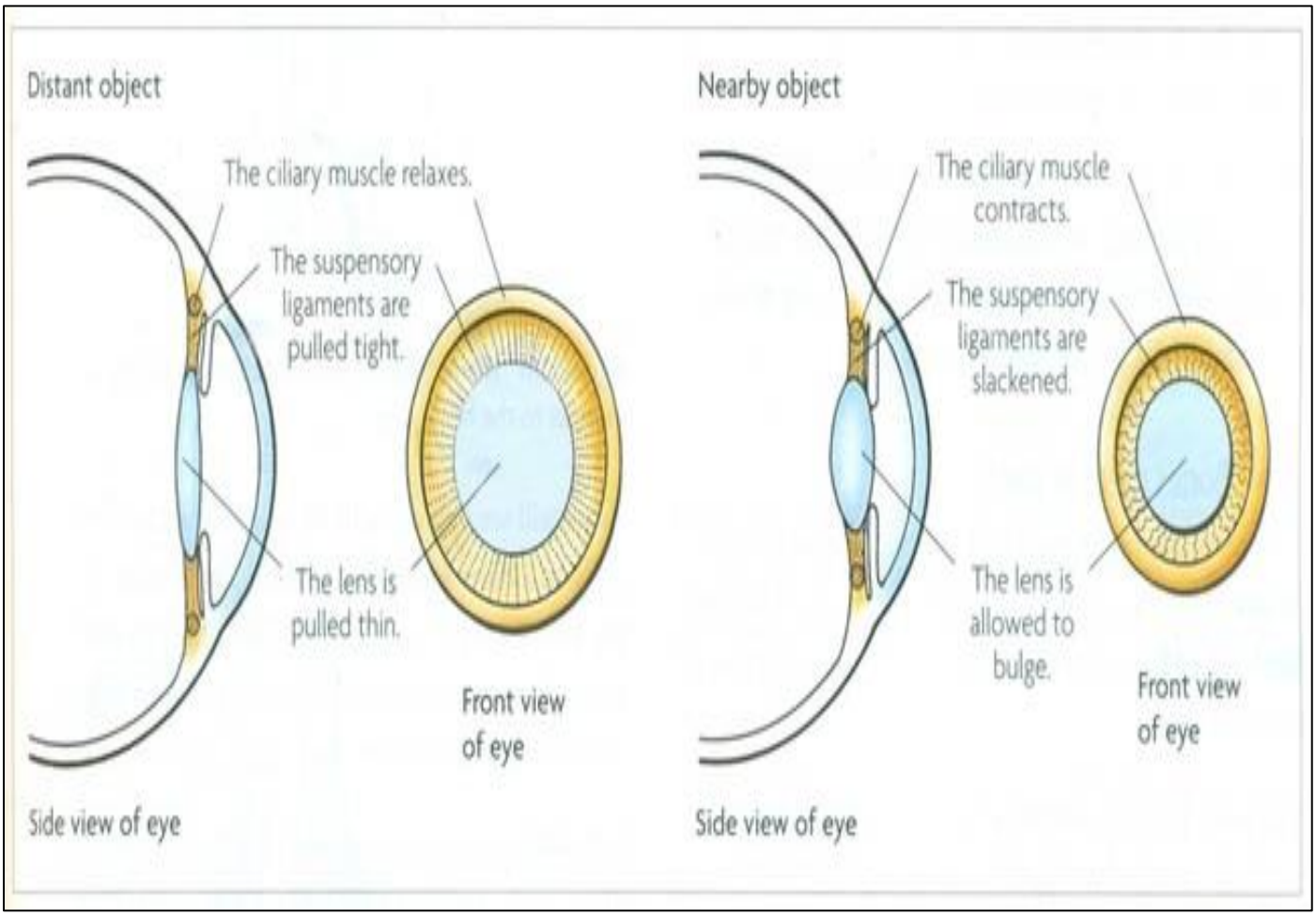

Fig 2 Changes in the Crystalline Lens During Accommodation
https://biology-igcse.weebly.com/-accommodation.html

➢ *Far Point and Near Point of the Eye*

The nearest point at which small objects can be seen clearly is called near point or punctum proximum and the distant point is called far point or punctum remotum.[6]

- *These Vary with the Static Refraction of the Eye as Shown Below:*

✓ In an emmetropic eye far point is infinity and near point varies with age.[6]
✓ In hypermetropic eye far point is virtual and lies behind the eye.[6]
✓ In myopic eye, it is real and lies in front of the eye.[6]

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

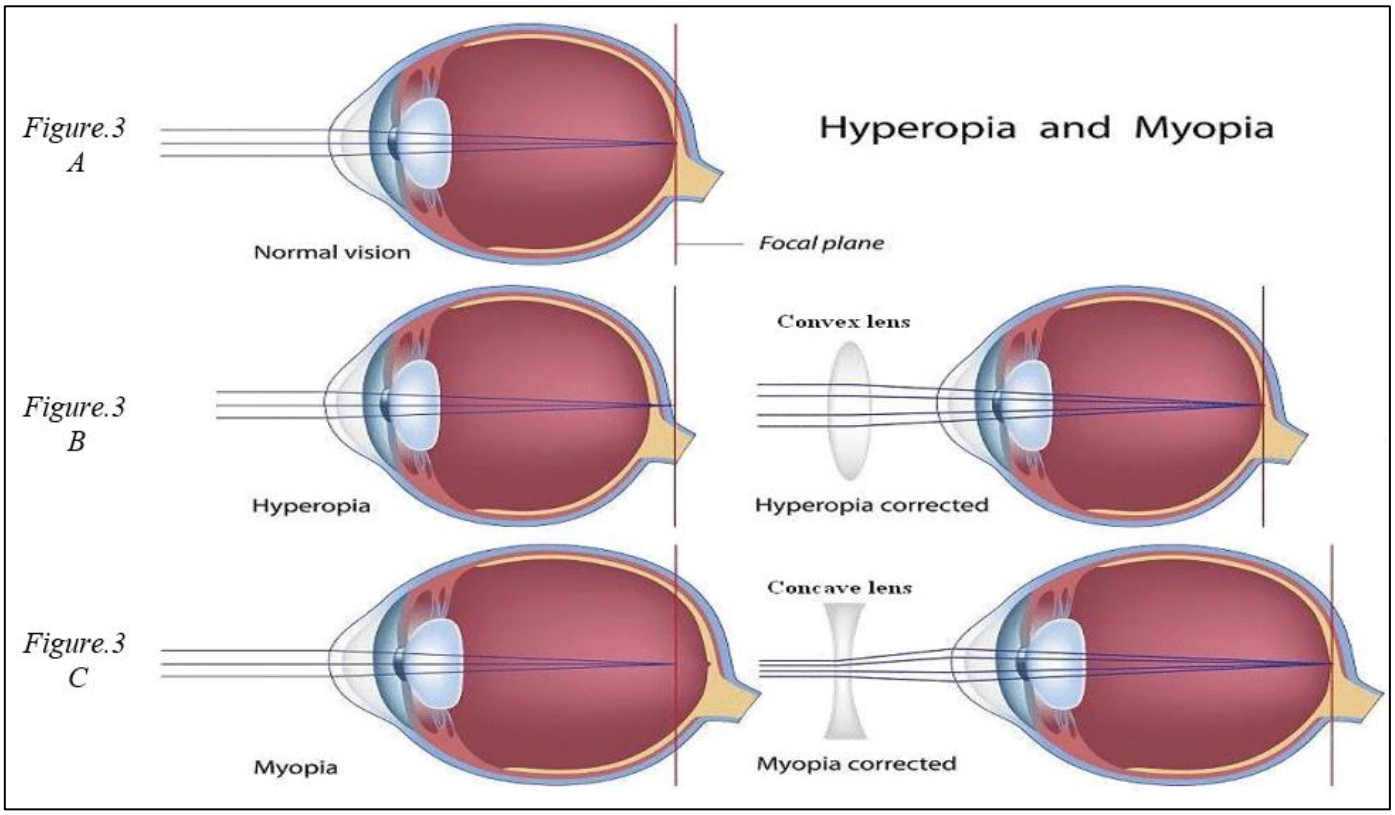

Fig 3 Far Point in Emmetropic Eye (A); Hypermetropic Eye (B); Myopic Eye (C)
(https://images.app.goo.gl/KETxYKR5MNE7ZRTt7)

➢ *Range And Amplitude of Accommodation*

- *Range of Accommodation*
  The distance between the near point and the far point is called the range of accommodation.[6]

- *Amplitude of Accommodation*
  The difference between the dioptric power needed to focus at near point (P) and far point (R) is called amplitude of accommodation (A). Thus A = P–R[6]

Amplitude of accommodation and thus the near point of vision (punctum proximum) vary with age.[6]

Table 1 Estimate of Amplitude of Accommodation and Near Point at Different Ages
https://www.opticianonline.net/cpd-archive/6237

Age (years)	Amplitude of accommodation (Dioptres)	Near point (cm)
5	15.00	5
10	12.50	8
20	9.75	10
30	7.25	14
40	4.00	25
50	2.50	40
60	1.25	80
70	0.50	200
75	0.00	∞

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

- *Vergence*

Vergences are disjugate, synchronous and symmetric movements of the two eyes in opposite direction.[10] A vergence may be voluntary movement or an optometer reflex.[10]

The vergence angle is the angle formed between the lines of sight of the two eyes as they converge (or diverge) to focus on an object. This angle changes depending on the distance of the object being viewed:[11]

✓ Near object → larger vergence angle (convergence)
✓ Far object → smaller vergence angle (divergence)

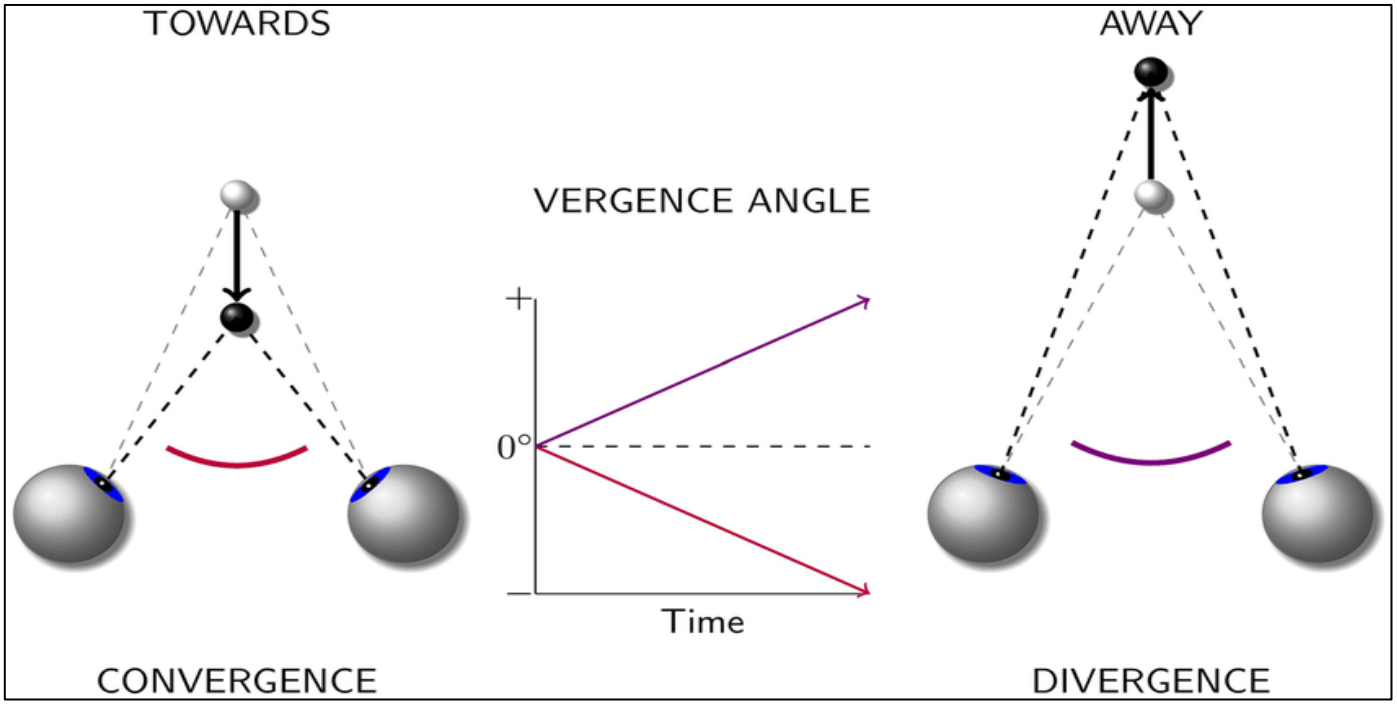

Fig 4 Vergence Angle
(https://www.nature.com/articles/s41598-019-53902-y)

➢ *Type of Vergence:*

- Convergence: It is simultaneous and synchronous inward rotattion of both eyes which results from co-contraction of the two medial rectus muscle.[10]
- Divergence: It is simultaneous and asynchronous outward rotation of both eyes which results from co-contraction of the two lateral rectus muscles.[10]
- Vertical vergence: Vertical vergence refers to disjugate vertical movements of the two eyes in opposite direction, i.e. one eye should rotate upward and the other downwrad.[10]
- Cyclovergence: Cyclovergence is the disjugate torsional movement in which the vertical meridians of the two eyes move in opposite direction to each others.[10]

➢ *Significance of Vergence:*

- Vergence helps maintain binocular single vision by aligning both eyes on the same target.[19]
- Vergence supports clear and comfortable near work by adjusting eye posture for varying distances.[19]
- Vergence ensures accurate depth perception through proper ocular alignment.[19]
- Vergence reduces asthenopic symptoms such as eye strain during prolonged visual tasks.[19]
- Vergence stabilizes fusion and prevents diplopia by coordinating extraocular muscle actions.[19]

➢ *AC/A Ratio*

The AC/A ratio is the ratio of the amount of accommodative- convergence measured in prism diopters to the number of dioptre of accommodation which causes this convergence.[5] This relationship is a linear one and is thought to be relatively stable throughout life. In it, the accommodative convergence is measured in prism diopter and the accommodation in lens diopter.The AC/A ratio is ,

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

therefore, expressed as so many prism diopters per 1D of accommodation.The normal AC/A ratio is about 3-5ΔD for 1D of accommodation.[5]

AC/A ratio remains almost normal in presbyopic persons indicates that it is the stimulus for the accommodation that evokes the response of accommodative convergence rather than the amount of accommodation. The majority of myopes have a high AC/A ratio and hypermetropes have a low AC/A ratio as compared with the emmetropes.[5]

➢ *Significance of AC/A Ratio*

Abnormalities of AC/A ratio are very important cause of strabismus. A high AC/A ratio may cause excesssive convergence and produced a convergent squit (esotropia) during accommdation on near object. A low AC/A ratio may cause a divergent squint(exotropia) when a patient looks at a near object.[5]

➢ *Types*

- Stimulus AC/A ratio -amount of accommodative convergence produced by a change of 1D in the stimulus to accommodation.
- Response AC/A ratio - Amount of accommodative convergence produce by an actual change of 1D of accommodation.[7]

➢ *Methods of Calculation of AC/A Ratio*

- Heterophoria method
- Gradient method
- Graphical method
- Fixation disparity method[7]

➢ *Uses of AC/A Ratio*

- Diagnosis of convergent excess type of esodeviation.
- Divergence excess esodeviation
- Divergence insufficiency
- Convergence insufficiency[7]

➢ *Visual Comfort*

Visual comfort refers to the ability of the visual system to function effeciently and comfortably during various visual tasks without causing symptoms such as eye strain, headache, blurred vision or fatigue. It reflects the balance between the visual demands of the task and the functional capacity of the patient's ocular and visual system. A visually comfortable environment ensures that the eyes can function efficiently, reducing stress and enhancing productivity, well-beingand overall user satisfaction.[8]

Visual comfort is influenced by multiple optometric factors, including refractive error, accomodation, vergence, binocular vision status, ocular health, and the quality of the visual environment (lighting, glare, contrast, and working distance). When these factors are not aligned, patients may experience asthenopic symptoms, reducing reading performance and difficulty sustaining near tasks- particularly in activities such as digital device use, prolonged reading, and precision work.[9]

For optometrists. assessing visual comfort is essential in diagnosing binocular vision anomalies, accomodative dysfunction, digital eye strain, and refractive issues. Intervention may include prescribing corrective lenses,vision therapy, ergonomic modifications, or lighting adjustments. As modern lifestyles, increase near-work demands, especially with digital screens, visual comfort has become a key focus of contemporary optometric care.[9]

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER TWO
LITERATURE REVIEW

➢ *Literature Review*

- Ashraf M. N. et al. (2024) conducted a descriptive, cross-sectional observational study at Noor Aleioon Hospital to evaluate the effect of blue light filter intraocular lenses (IOLs) on colour vision. The study included 103 patients who had undergone unilateral cataract surgery with blue-filter IOL implantation. Participants with bilateral surgeries or ocular and systemic diseases affecting colour vision were excluded. Data were collected through structured interviews and the D15 colour vision test, and were analysed using SPSS and Microsoft Excel. Among the 103 participants (206 eyes), 55.3% were female, with a mean age of 58.38 years. The findings revealed that 78.6% of participants exhibited normal D15 colour vision, while 21.4% showed various colour vision defects—specifically tritanomaly (9.7%), deuteranomaly (6.8%), and protanomaly (4.9%). Minimal gender differences were observed in test performance. The study concluded that blue-filter intraocular lenses have a notable impact on photopic colour vision, as a significant proportion (21.4%) of patients demonstrated abnormal colour vision results following implantation.

- Ugam P. S. U. et al. (2023) conducted an experimental study to assess the effect of blue light filters on visual and task performance among 40 emmetropic subjects aged between 19 and 23 years. The study evaluated participants' performance with and without blue light filters using a range of visual and task-related assessments, including reading, data entry, and fatigue evaluation. Data were analyzed using SPSS software, with statistical significance determined through ANOVA and paired t-tests at a 5% significance level ($p < 0.05$). The results indicated that blue light filters significantly enhanced visual and task performance. Participants demonstrated a notable improvement in post-task accommodative response, along with increased reading speed and data entry accuracy when using the filter. Furthermore, subjective visual fatigue levels were reduced compared to conditions without the filter. The authors concluded that blue light filters effectively improve accommodative response and task performance while reducing visual fatigue, suggesting their potential to enhance visual comfort and efficiency, provided that display quality remains unaffected.

- Tatsumoto et al. (2023) conducted a clinical study to evaluate the effectiveness of Blue Cut for Night (BCN) glasses, which selectively block short-wavelength blue light between 480–500 nm, in alleviating migraine-related symptoms and photophobia. The study included ten migraine patients who consistently experienced light sensitivity. Participants were instructed to wear BCN glasses for at least three hours daily after dark over a 28-day period. Data were collected on headache frequency, pain intensity, and photophobia levels, along with medication use and psychological parameters. Results revealed a significant reduction in the frequency and severity of headaches, as well as marked improvement in photophobia, particularly during nighttime exposure. There were no substantial changes in the use of medication or psychological measures, suggesting that the improvement was primarily due to the optical intervention. The authors concluded that BCN glasses effectively reduce migraine-associated discomfort and light sensitivity, providing a safe, simple, and non-pharmacological approach for patients with migraine-related photophobia. The findings support the use of blue light–blocking eyewear as an adjunctive tool in the management of migraine symptoms, enhancing patient comfort and quality of life.

- Adiba A. et al. (2021) conducted an exploratory study to investigate the effect of blue light filtering lenses (BFLs) on speed perception. The study included twenty participants with normal vision who were exposed to both colored and achromatic Gabor stimuli. Using a dichoptic setup, the participants viewed test stimuli through BFLs and reference stimuli through clear lenses. The stimuli varied in speed and color, and the perceived motion speed was assessed using a two-interval forced-choice design. The results revealed that BFLs significantly reduced the perceived speed and contrast of blue and achromatic stimuli, whereas red stimuli were unaffected. The study also demonstrated that this reduction in perceived speed was strongly correlated with the reduction in visual contrast, indicating that contrast plays a crucial role in motion perception. The authors concluded that BFLs, by filtering short-wavelength light, may lower visual contrast and consequently affect both visual perception and circadian rhythm.

- Alexander D. et al. (2019) conducted a two-week study to assess the effect of blue light filtering lenses (BLFL) on computer vision syndrome among radiology residents. Ten participants alternated between wearing BLFL and non-BLFL glasses while working, with daily surveys (CVS-Q and SOFI) used to measure eye strain and fatigue. Statistical analysis using Mann–Whitney and ANOVA tests showed no significant difference between the two conditions; however, symptom scores were consistently lower with BLFL. Female residents and PGY-2 trainees reported higher symptom severity. The authors concluded that although the findings were not statistically significant, BLFL may help reduce visual discomfort and are safe for regular use.

- Asmaa J. et al. (2019) conducted a cross-sectional study to evaluate the perception of sleep disturbances caused by bedtime use of blue light-emitting devices and their impact on sleep quality among young medical and pharmacy students in Rabat, Morocco. A total of 294 students participated by completing an anonymous online survey using Google Forms, which gathered data on device usage habits and sleep quality through the Pittsburgh Sleep Quality Index (PSQI). Statistical analysis was performed using SPSS with a significance level of $p < 0.05$. The study revealed that 97.3% of students used blue light-emitting devices at

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

bedtime, with 35.3% experiencing poor sleep quality. Although 65.7% acknowledged that such device use affected their sleep, most continued using them mainly for leisure purposes. Longer screen exposure and frequent sleep interruptions were associated with poorer sleep outcomes, with no significant gender differences. The authors concluded that bedtime use of blue light-emitting devices is prevalent among students and is linked to reduced sleep quality and increased fatigue, emphasizing the importance of reducing nighttime screen exposure.

- John G. L. et al. (2017) evaluated the effect of blue cut for night (BCN) glasses in migraine patients with photophobia, particularly during night driving. Ten women participated, completing a 28-day baseline period followed by 28 days of BCN glasses use for at least three hours nightly. Headache frequency, light sensitivity, and related symptoms were tracked using diaries and standardized tools such as HIT-6, BDI, and PSQI. The study found a significant reduction in headache days (from 8.7 to 7.0, $p < 0.05$) and decreased photophobia intensity across all lighting conditions. However, no significant changes were noted in sleep quality, mood, or medication use. The authors concluded that BCN glasses may provide a simple, non-invasive option for managing migraine-related light sensitivity.

- Tsz Wing L. et al. (2017) evaluated the optical and clinical performance of five blue-light filtering spectacle lenses, examining their effects on vision, eye safety, and melatonin regulation. The lenses reduced blue light through reflection or absorption while effectively blocking ultraviolet radiation. Results showed minimal impact on visual performance, contrast sensitivity, color vision, or sleep quality, though a slight reduction in night vision sensitivity and melatonin suppression was observed. Participants preferred clear-coated lenses over tinted ones. Overall, blue-light filtering lenses were found to provide potential eye protection and improved visual comfort without major visual drawbacks.

➢ *Need of Study*

- To identify and address the vergence, accommodation parameters and visual comfort on wearing blue light filters glasseswhile using laptop.

➢ *Hypothesis*

- *Null Hypothesis(H0):*

Short-term use of a blue light filter during laptop work has no significant effect on accommodation, vergence, or visual comfort compared to no filter.

- *Alternate Hypothesis(H1):*

Short-term use of a blue light filter during laptop work improves accommodation accuracy, enhances vergence stability, and increases visual comfort compared to no filter.

➢ *Aim & Objectives*

➢ *Aim:*

To compare the impact of blue light filters lens (BLFL) on pre & post vergence and accommodation parameters and visual comfort.

➢ *Objectives:*

- To determine the acute effects of BLFL on accommodation parameters (NPA, AF).
- To determine the acute effects of BLFL on vergence parameters (NPC, VF).
- To determine the acute effects of BLFL on visual comfort before and after wearing BLFL.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER THREE
MATERIAL & METHODOLOGY

➢ *Methodology*

- Study site: Shridevi Institute of Allied Health Sciences, Tumkur.
- Source of data: Students of Shridevi Institute of Allied Health Sciences, Tumkur.
- Study design: Prospective experimental study
- Sampling method: Convenience sampling
- Sample size: 48 participants
- Study duration:April 2025-November 2025

- *Sample Size Justification:*

The sample size is calculated using a study conducted by Wang, C. et.al (2023). The study shows a prevalence rate of computer vision syndrome among university students 80% (Approx.). At 90% confidence level and an absolute allowable error of 5%. The sample size is calculated using below condition.

➢ *Sample Calculation Formula:*

$$\text{Sample size: } n = \frac{Z^2 * p * q}{E^2}$$

$$= \frac{(1.645)^2 * 0.80 * (1 - 0.80)}{(0.1)^2}$$

$$= \frac{2.706 * 0.80 * 0.20}{0.01}$$

$$= 43.2964 + 10\% \text{ non-response rate}$$

$$= 43.2964 + 4.3296$$

$$= 47.626$$

$$\cong 48$$

The total 48 subjects will be considered for the study.

Where, p= Expected prevalence rate of blue light filter

q=1-p

Z= Standard normal variate at 90% is 1.645

E=Margin of error

Fig 5 Slit Lamp

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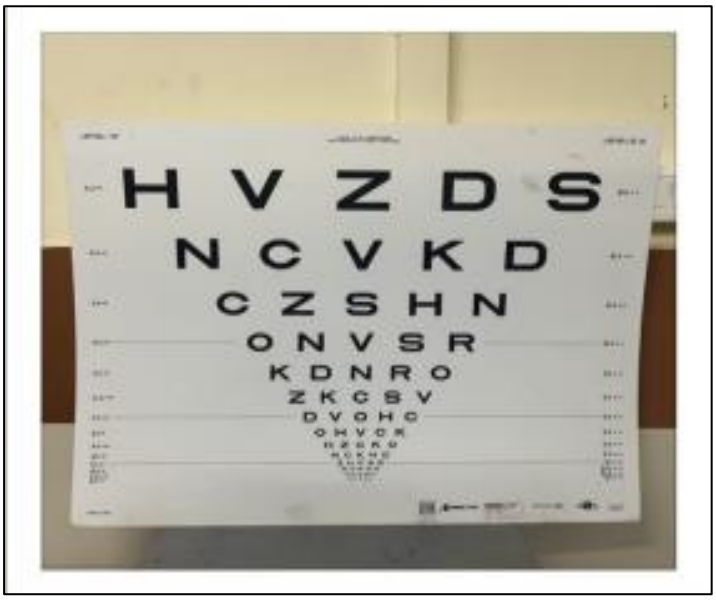

Fig 6 Logmar Chart (Self Image)


Fig 7 Retinoscope & Ophthalmoscope (Self Image)

Fig 8 RAF Ruler (Self Image)

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Fig 9 Vergence Flipper (Self Image)

Fig 10 Accommodative Flipper (Self Image)

Fig 11 Occluder (Self Image)

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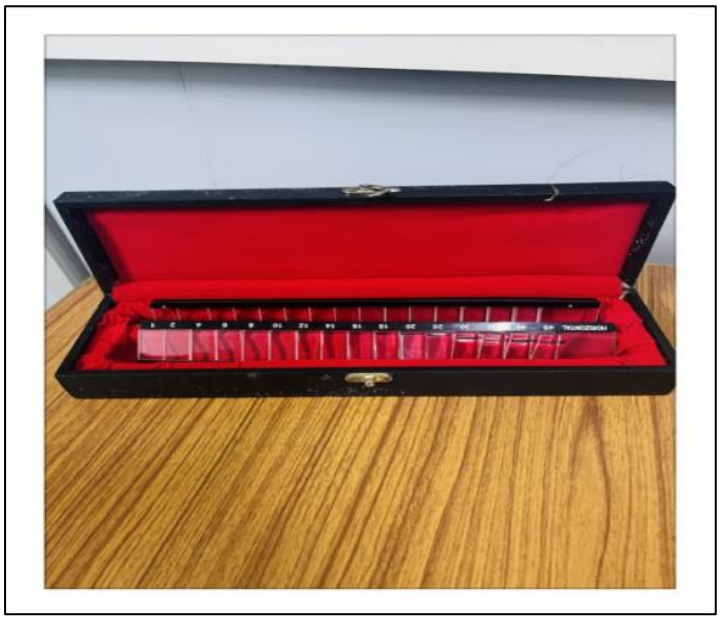

Fig 12 Horizontal & Vertical Prism Bar (Self Image)

Fig 13 Laptop (Self Image)

Fig 14 Pentourch (Self Image)

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Fig 15 Luxmeter (Self Image)

Fig 16 Near Vision Chart (Self Image)


Fig 17 Blue Light Filter Lens (Self Image)

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Table 2 Technical Information About the BLFL Used

Brand Name	**Lenskart BLU Screen Glasses**
Product Type	Zero power screen glasses
Frame Type	Full Rim
Frame Shape	Square
Manufacturer Detail	BaofengFramekart Technology Limited
Country of Origin	India
Model no.	LB E13526
Frame Size	Medium
Frame width	135mm
Frame Dimension	51-17-135
Frame Colour	Crystal Transparent
Weight	15gm
Weight Group	Light
Material	TR90 (Flexibile Light Weight)
Frame Material	TR90
Temple Material	TR90
Prescription Type	No Power
range of blue light block(nm)	415-460
Blue Light Blockage	95%
Type of Coating	Single (Outer Coating)
Refractive Index	1.56
Thickness of Lens	1.8mm
ARC	absent
Antifog	absent

➢ *Inclusion Criteria*

- Age range between 18 – 28 years.
- Emmetropes/all participants must have 0.0 Log unit (6/6) vision without subjective correction.
- Subject should be free from systemic and ocular disease.
- Regular sleep pattern (habitual sleep 6–9 hours/night).
- Voluntary participation with informed consent.

➢ *Exclusion Criteria*

- History of ocular dieseas or conditions like strabismus(except phoria), amblyopia.
- Participation in another ophthalmic/vision trial within the past 30 days.
- History of eye surgery and trauma.
- Inability to maintain required laptop viewing posture or fixation for the test duration
- Those with prior visual discomfort or digital eye strain symptoms.
- Participant used digital devices 3 hour prior to examination.

➢ *Methodology*

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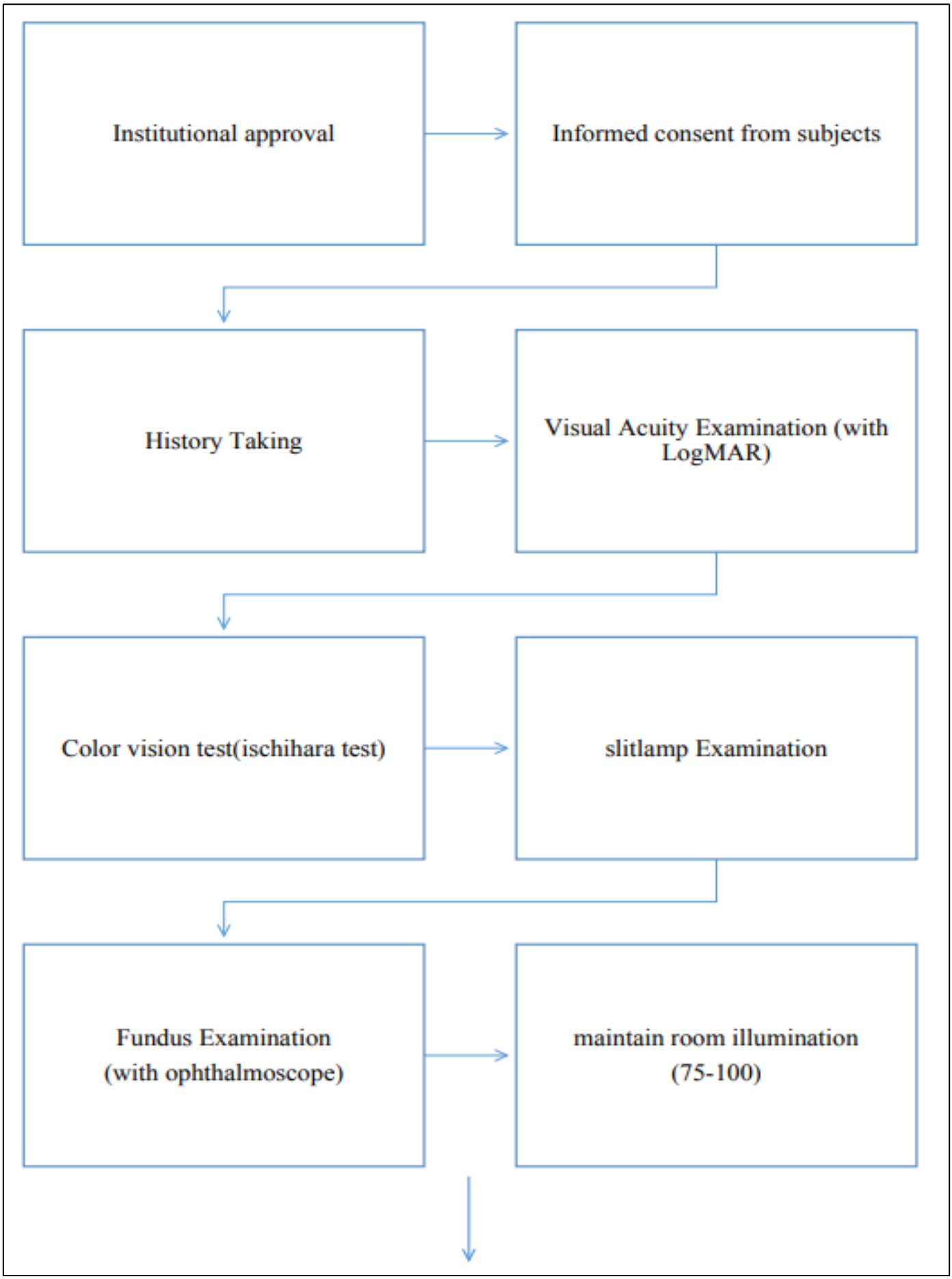

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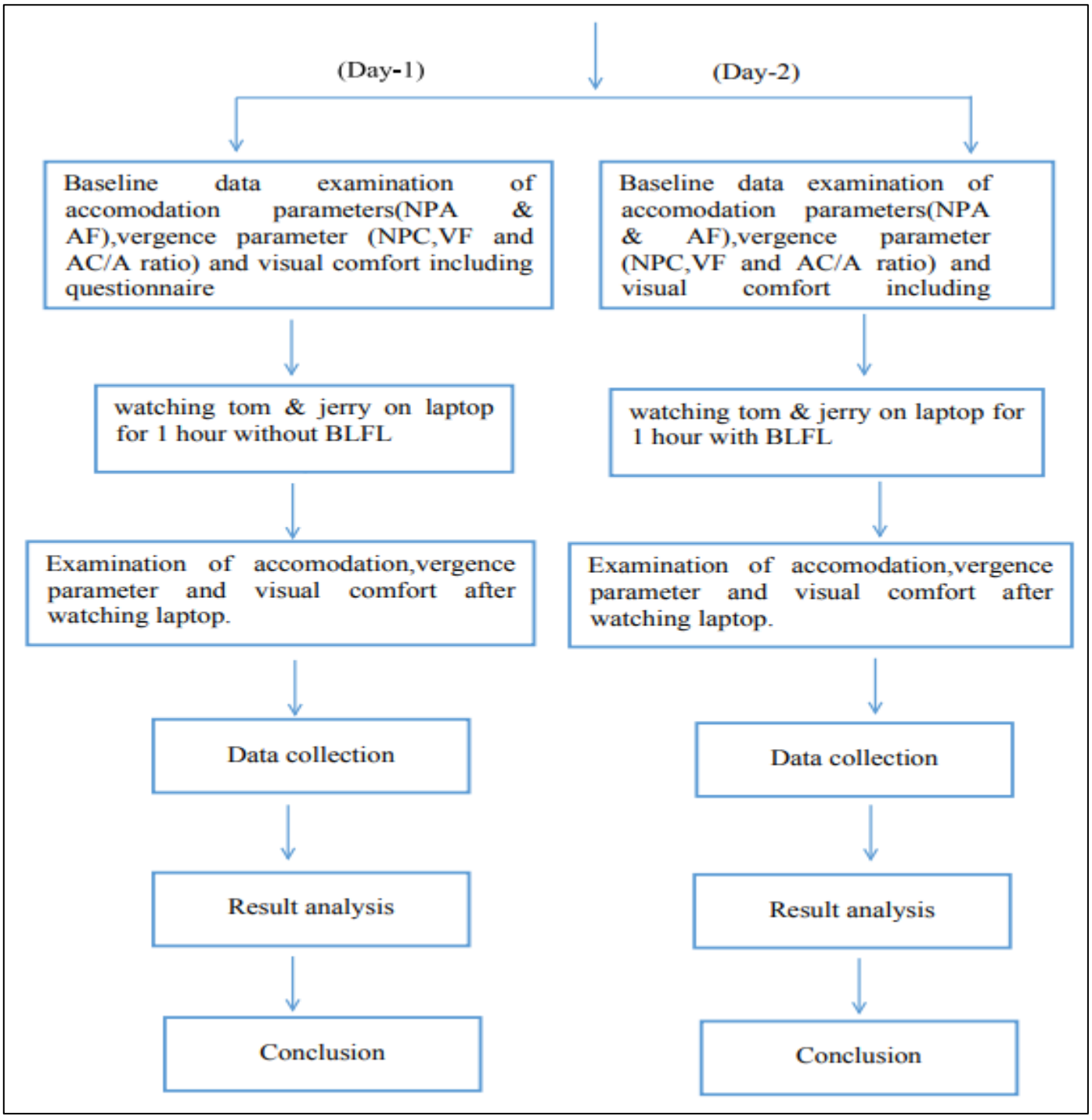

Fig 18 Flow Chart of "Procedure / Methodology."

Subjects were selected from Shridevi Institute of Allied Health Science of Tumkur from 2025. The purpose of the study was explained and informed, consent was taken from them.

All the participants had to undergo a comprehensive ocular examination. Eyes that fulfilled the inclusion criteria were selected for further assessment and 48 subjects were selected for this study. Visual Acuity, Subjective Refraction, Objective Refraction, Slit Lamp Examination, Fundus Examination, Accommodation Parameters (Near Point of Accommodation, Accommodative Facility,) & Vergence Parameters (Near Point of Convergence, Vergence Facility & AC/A ratio). 16 quiotionnaire based on computer vision syndrome by Arne aaras were asked to each participant to evaluate the visual comfort.The detailed procedure performed in the study is explained below.

- *History Taking:*

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History taking is an essential part of an eye examination used to gather detailed information and recording their Demographic History such as Name, Age, Gender, Address, Contact Info proceeded by Chief Complaints, Ocular History, Systemic History, Medical History, Family History, Social History is documented.[12]

➢ *Visual Acuity:*

- *Distant Visual Acuity:*

Distance visual acuity (VA) measures the eye's ability to distinguish details at a distance, commonly using a LogMAR (Logarithm of the Minimum Angle of Resolution) chart. LogMAR provides a standardized, precise scoring system for visual acuity assessment, allowing accurate comparison of visual performance and treatment outcome[13]).The subject was asked to sit comfortably and read with each eye separately. Then the Visual Acuity was recorded (Aided & Unaided).

✓ *The Formula Used in Calculating the Score is:*

❖ Log MAR VA = 0.1 + Log MAR value of the best line read – 0.02 X (number of optotypes read)
❖ Log MAR VA = Log MAR value of the best line read + 0.02 X (number of optotypes missed) [13]

- *Near Visual Acuity:*

Near visual acuity was tested with the help of Roman test type at 40cm.[14]The subject was asked to read the chart kept at 35 - 40cm with the good illumination.[14] Each eye was tested separately and recorded.[14]

➢ *Slit Lamp Examination:*

The slit lamp examination is a fundamental procedure in ophthalmology and optometry used to assess the anterior and posterior segments of the eye in detail. It employs a bio microscope combined with a high-intensity light source that can be focused into a thin slit, allowing a magnified, three-dimensional view of the ocular structures. The examination begins with inspection of the external eye, including the eyelids and eyelashes, followed by evaluation of the conjunctiva and sclera for signs of redness, discharge, or lesions. The cornea is then examined for clarity, edema, or ulceration, often enhanced with fluorescein dye to detect epithelial defects. The anterior chamber is assessed for depth, inflammation, or the presence of cells and flare, while the iris is checked for abnormalities such as nodules or neovascularization. The crystalline lens is examined for opacities indicating cataract formation, and the anterior vitreous is inspected for floaters or hemorrhage. This examination provides crucial information for diagnosing conditions like keratitis, conjunctivitis, uveitis, and cataract, and for monitoring post-operative and contact lens-related changes.[14]

➢ *Fundus Examination:*

Fundus examination is a routine eye assessment performed by using ophthalmoscope to inspect the retina, optic disc, blood vessels and macula through pupil. Subject was informed about the procedure and fundus examination was performed by direct ophthalmoscope through undilated pupil. Subject were asked to look at distance object while performing the procudure. Requirement of the procedure like dim illumination, proper technique were maintain. Examination of all the structures like optic disc, retinal blood vessels,macula and all retinal quadrant were done and recorded monocularly.[15]

➢ *Accomodation:*

- *Near Point of Accomodation:*

NPA is the closest point at which an object can be seen clearly when the eye exerts maximum accomodation[16]. At first subject was explained about the procedure and ask to seat comfortably in good illumination room. The RAF ruler was placed across the patient nose alingned with subject visual axis. N8 target of the RAF ruler was hold at the distance of 50cm infront of one eye(the other eye were occluded). subject were instructed to focus on target and keep it clear. Now slowly the target were moved closure to the subject eye until it becomes blurry/difficult to read.Record the measurement in centimetre from the target becomes blurry.[17]

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Fig 19 Near Point of Accommodation (Self Image)

- *Accommodative Facility:*

Accomodative facility refers to the speed or flexibility of the accommodative system- how quickly and accurately the eyes can change focus from distance to near and back again.[18]


Fig 20 Accomodative Facility (Self Image)

AF was performed first uniocularly and then binocularly. At first subject were instructed about the procedure and make them seat comfortably. It was performed using accommodative flipper ±1.50 D and Word Rock Card from the distance of 40 cm in proper lightning condition.

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Instruct the subject to read one word at a time only when the word become clear. Then set a time of 1 minute in a clock. Flip the flipper once the subject is able to read the words.After 1 minute count the number of cycles (one flip of +1.50 D & one flip of -1.50D is considered as One Cycle) the subject completes in 1 minute.[6]

➢ *Vergence:*

- *Near Point of Convergence:*

The Royal Air Force (RAF) rule was placed on the bridge of the participants's nose, they were asked to fixate on the linear target on the carrier. Examiner will move the target closure to the subject and the participants were asked to inform the examiner when the target become double. It was then pulled back until it was single and the distance from the ruler recorded. This test was undertaken BE only.[6]

- *Vergence Facility*

It was done binocularly using vergence flipper (12 Prism Dioptre BO and 3 Prism Dioptre BI)[16]. Subject were given a linear target and instructed to focus the target clearly so that the linear target is appreciated as a single at the distance of 40 cm. Vergence flipper were placed infront of the eyes. Similarly 1 minute of time were set and the test were initiated. Subject were instructed to informed only when the linear target is appeared as a single.After 1 minute total reading were recorded, 2 readings is equal to 1cpm.[20]

- *AC/A Ratio:*

AC/A ratio were calculated using the heterophoric method. This procedure involves first measuring the Interpupillary distance (IPD) in centimeters. Then distance phoria (usually at 6 meters) were measured by using the prism bar through cover test. Similarly near phoria (commonly at 33 cm) were recorded through the same prism bar[21,18]. The heterophoric method formula is :

Fig 21 Cover Uncover Test (Self Image)

AC/A= IPD (cm) +[Δn-Δd]/D

Where:

IPD= interpupillary distance in cm

Δn= near phoria (eso is plus and exo is minus)

Δd=far phoria (eso is plus and exo is minus)

D=near fixation distance in meter

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

Fig 22 Pd Measurement (Self Image)

➢ *Visual Comfort:*

Subjective visual comfort were assessed using questionnaire developed by arne aaras et ,al. (1998).[22] Each question was classified into the following three categories, and each statement was rated from "0"- "2", that is, if the symptoms were, "extremly noticeable," then they were graded as "2";if "somewhat noticeable," then "1" ; and if "not noticeable at all" then "0". All the 16 questionnaire were asked to the subject before and after using the laptops for 1 hour both with and without the use of BLFL.[23,2] The 16 questionnaire based on symptoms included were burning,itching, foreign body senstation, tearing, excessive blinking, eye redness, eye pain, heavy eyelids, dryness, blurred vision, double vision, difficulty focus near, light sensitivity, color halos, sight worsening and headache.

➢ *Statistical Analysis*

- *Statistical Analysis Plan:*

The statistical analysis with done by excel and R-programming of version R. 4.4.2. Researchers will calculate the demographic details by descriptive statistics in the form of mean, standard deviation. The categorical variables will be presented in the form of percentages and proportions. The data will be presented by diagrams and graphs. To compare the dependent variables t-test can be applied wherever necessary. A significance level of 0.05 ($p<0.05$) is considered for statistical significance.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER FOUR
RESULT

➢ *Results*

Table 3 Descriptive Statistics of Baseline Parameters

Parameters	Sub-group	Mean	SD	Min	Max	Interpretation
NPA (cm)	OD	8.15	1.60	5.00	11.50	The spread (SD=1.60) shows that variability is moderate.
	OS	8.24	1.60	5.00	12.00	The values indicate normal accommodative amplitude.
	OU	7.39	1.52	4.50	10.50	More consistency is indicated by a lower standard deviation.
AF (cpm)	OD	11.25	3.70	3.50	17.50	Wide variation is indicated by a high standard deviation.
	OS	10.83	3.89	3.50	19.50	A wide standard deviation indicates variation in flexibility.
	OU	12.47	3.29	6.00	20.00	The lot of variances are observed.
NPC (cm)	Break	5.93	0.93	3.80	8.80	The mean shows variability; some patients may have insufficient early convergence.
	Recovery	9.25	1.06	6.30	11.20	The mean is slightly out of the ordinary. Shows that some participants have modest convergence stress.
VF (cpm)		14.72	2.04	8.50	19.50	Low SD shows consistency between individuals.
AC/A ratio		0.25	0.00	0.25	0.25	No variation is observed.

- *Interpretation:*

The descriptive statistical analysis of the visual function data demonstrates that the accommodative parameters and vergence measures are mainly within normal physiological ranges, with minor heterogeneity among people. The Near Point of Accommodation (NPA) values for both eyes and binocular vision reveal appropriate accommodative amplitude, with binocular performance somewhat better than monocular, which accords with expected physiological behaviour. The accommodative facility (AF) values reveal greater variability, with mean binocular values higher than monocular, indicating superior accommodative flexibility during binocular gazing. However, the relatively high standard deviations suggest that certain individuals may have limited accommodative endurance or trouble shifting focus fast. The Near Point of Convergence (NPC) break and recovery values indicate mostly usual convergence ability, although the recovery values reach the upper borderline clinical limits, suggesting that a subset of participants may exhibit mild coordination inefficiency or experience visual discomfort during prolonged near tasks. The vergence facility results reveal adequate binocular coordination, with little variability and values within normal ranges. Overall, the binocular assessments typically beat monocular values, indicating normal oculomotor adaptation mechanisms. While most participants display visual performance within clinically acceptable levels, a portion may require further examination or care for accommodative or convergence stress. The AC/A ratio seems constant in the dataset and hence is not interpretable as a meaningful clinical value. The AC/A ratio seems constant in the dataset and hence is not interpretable as a meaningful clinical value. In summary, the findings reveal largely normal binocular vision status with modest changes, especially in accommodative capability and convergence recovery metrics.

Table 4 Effect of Parameter Values by Descriptive Statistics

Parameters	Sub-group	Baseline D-1 Mean±SD	Without BLF D-1 Mean±SD	Baseline D-2 Mean±SD	Without BLF D-2 Mean±SD	p-value
NPA (cm)	OD	8.15±1.60	8.68±1.90	8.18 ±1.60	8.36±1.64	0.085
	OS	8.24±1.60	8.67±1.86	8.27±1.62	8.33±1.51	0.038
	OU	7.39±1.52	7.82±1.78	7.48 ± 1.52	7.61±1.61	0.279
AF (cpm)	OD	11.25±3.70	11.59 ±3.94	11.41±3.62	12.71±3.88	<0.001
	OS	10.83±3.89	11.29±3.79	10.97±3.84	12.32±4.31	<0.001
	OU	12.47±3.29	12.72±3.35	12.56±3.28	13.87±3.30	<0.001
NPC (cm)	Break	5.93±0.93	6.04±1.01	5.98±0.93	6.10±0.92	0.046
	Recovery	9.25±1.06	9.38±1.12	9.25 ±1.04	9.47±1.25	0.006
VF (cpm)		14.72±2.04	14.89±2.34	14.83 ±2.01	15.70±2.29	<0.001
AC/A ratio		0.25±0.00	0.25±0.00	0.25±0.00	0.25 ±0.00	0.42

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

- *Interpretation:*

Several visual performance metrics from two baseline sessions (Day 1 and Day 2) with and without blue light filter (BLF) lenses are compared in the table. Only the left eye (OS) showed a statistically significant improvement with BLF ($p=0.038$) for Near Point of Accommodation (NPA); the right eye and binocular measurements showed no discernible change. All three conditions (OD, OS, and OU) demonstrated a highly significant improvement in accommodative facility (AF) with BLF on both days ($p<0.001$), suggesting that employing blue light filtering lenses improves accommodative flexibility. The use of BLF resulted in slight increases in Near Point of Convergence (NPC) break and recovery values, both of which were statistically significant ($p=0.046$ and $p=0.006$, respectively), indicating that the lenses may contribute to a slight improvement in convergence stamina. Additionally, there was a significant improvement in vergence facility (VF) with lens use ($p<0.001$), indicating improved capacity to maintain and switch binocular focus. Conversely, the AC/A ratio did not alter under any of the settings ($p=0.42$), suggesting that the blue light filters had no effect on the accommodative–vergence interaction. Accommodative and vergence flexibility measures were generally the most sensitive to BLF, whereas static measures like AC/A and the majority of NPA parameters showed little to no change. According to these results, blue light filter lenses can be useful for tasks that call for dynamic focus adjustment.

Table 5 Distribution of Participants by Age-Group and Gender

Age-group	Male	Female	Total
18-20	4(17.39%)	8(32%)	12
20-22	7(30.43%)	5(20%)	12
22-24	7(30.43%)	7(28%)	14
24-26	3(13.04%)	4(16%)	7
26-28	2(8.70%)	1(4%)	3
Total	23(47.92%)	25(52.08%)	48

- *Interpretation:*

The age and gender distribution of a sample of 48 people, nearly evenly divided between males (23) and females (25), as shown in the table. Ages 18–20 and 22–24 make up the largest groups, each accounting for over 25% of the sample; in the youngest group, girls significantly outnumber males (18–20). In the 20–22 and 22–24 age groups, men are somewhat more prevalent, but in the 24–28 age group, both genders are less prevalent overall. Overall, the gender distribution is reasonably equal, with women being slightly more common. Comparative analyses across sexes and ages are made possible by this distribution, which indicates a young adult study sample with a very equitable gender representation. The gender balance reduces prejudice, and the preponderance of young people between the ages of 18 and 24 guarantees relevance to early adult binocular vision performance. The appropriateness of looking at physiological metrics like accommodation and convergence within typical young adult ranges is supported by this demographic mix. Results on accommodative parameters or binocular vision should take into account the minor trend heterogeneity in age and gender that is shown here. Overall, the table shows a well-distributed sample suitable for examining variations in young adults' visual function related to age and gender.

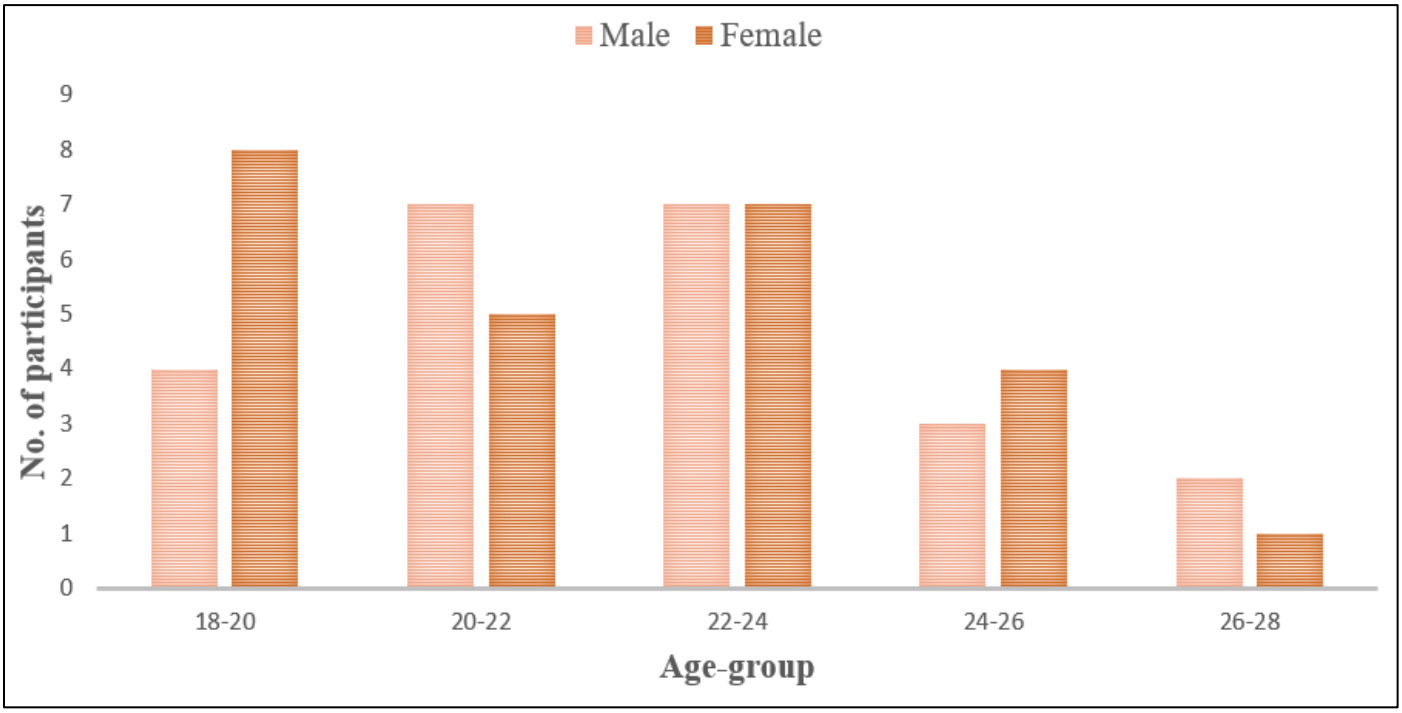

Fig 23 Distribution of Participants by Age-Group and Gender

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

- *Interpretation:*

The number of male and female participants in five different age groups—from 18–20 to 26–28 years—is depicted in the graph above. With a maximum of about 8 participants in each category, the sample size is quite modest. The age range of 18–20 to 22–24 comprises the largest group of participants, with roughly 8 males and 7 females. Participation declines with increasing age, especially beyond the 22–24 age range. There are regularly more female participants than male participants across all age categories. There are the fewest participants in the 26–28 age group—roughly two men and one woman.

Table 6 Distribution of Participants by Gender

Gender	No. of Participants
Males	23(48%)
Females	25(52%)

- *Interpretation:*

The study participants' gender distribution is shown in the table. Twenty-three (48%) of the sample's participants were men, while twenty-five (52%) were women. This suggests that both genders were almost equally represented in the study. A balanced but slightly female-dominated sample is suggested by the slightly higher percentage of females. In general, the gender distribution seems appropriate for extrapolating results to both groups.

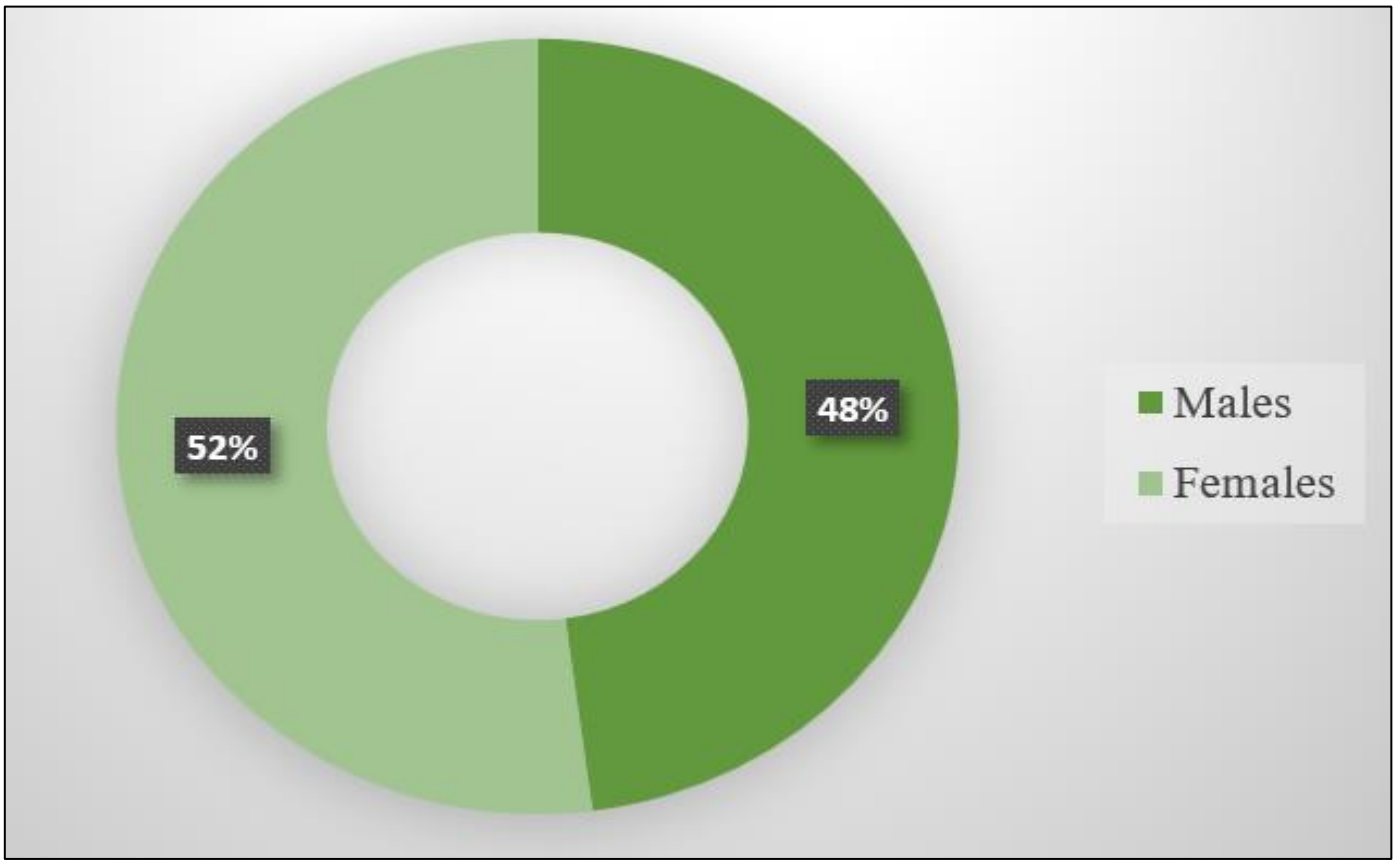

Fig 24 Distribution of Participants by Gender

- *Interpretation:*

The gender distribution of study participants is shown in the donut chart above. It represents 48% of all participants who are female and 52% of all participants who are male. For the study, gender distribution is almost equally taken into account.

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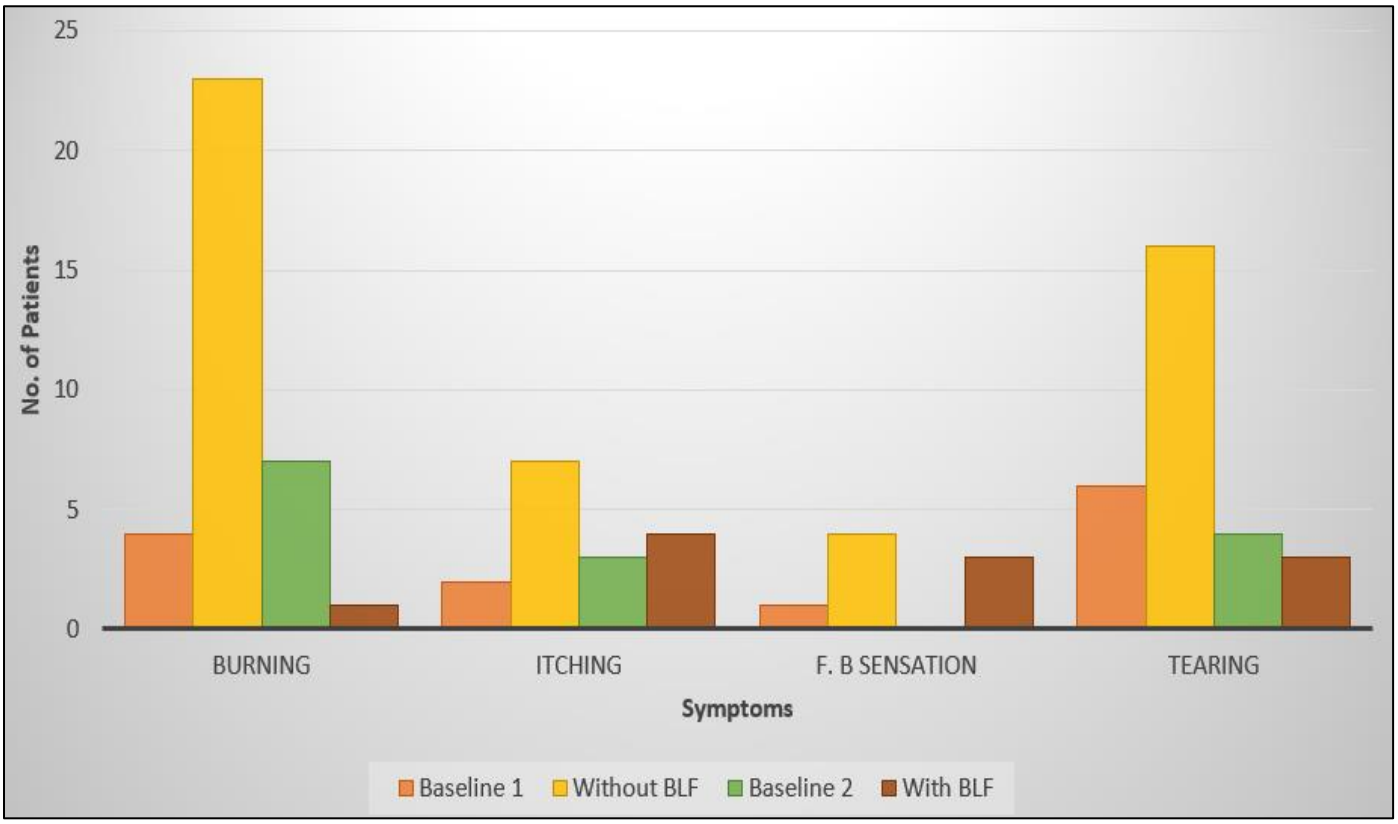

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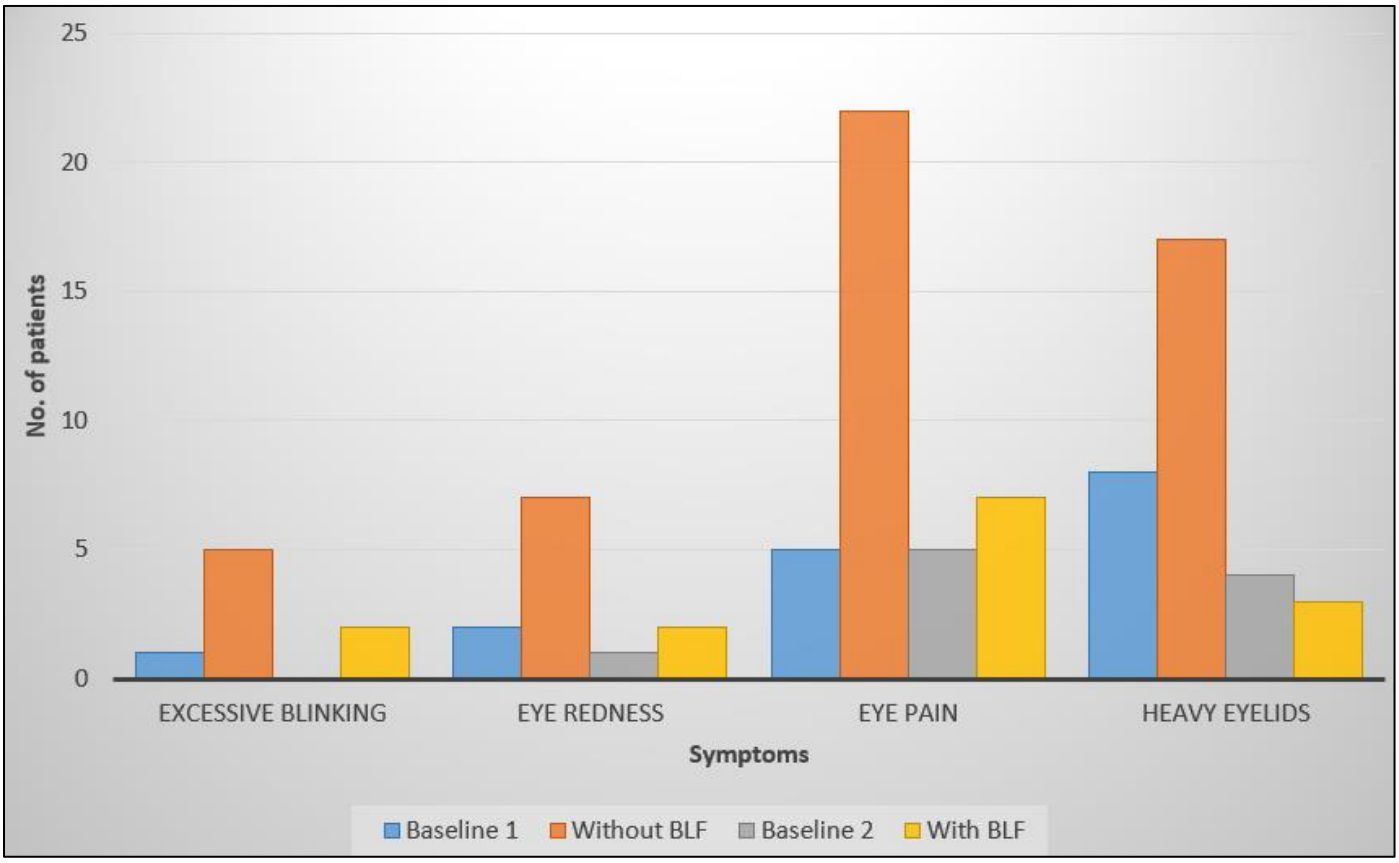

(b)

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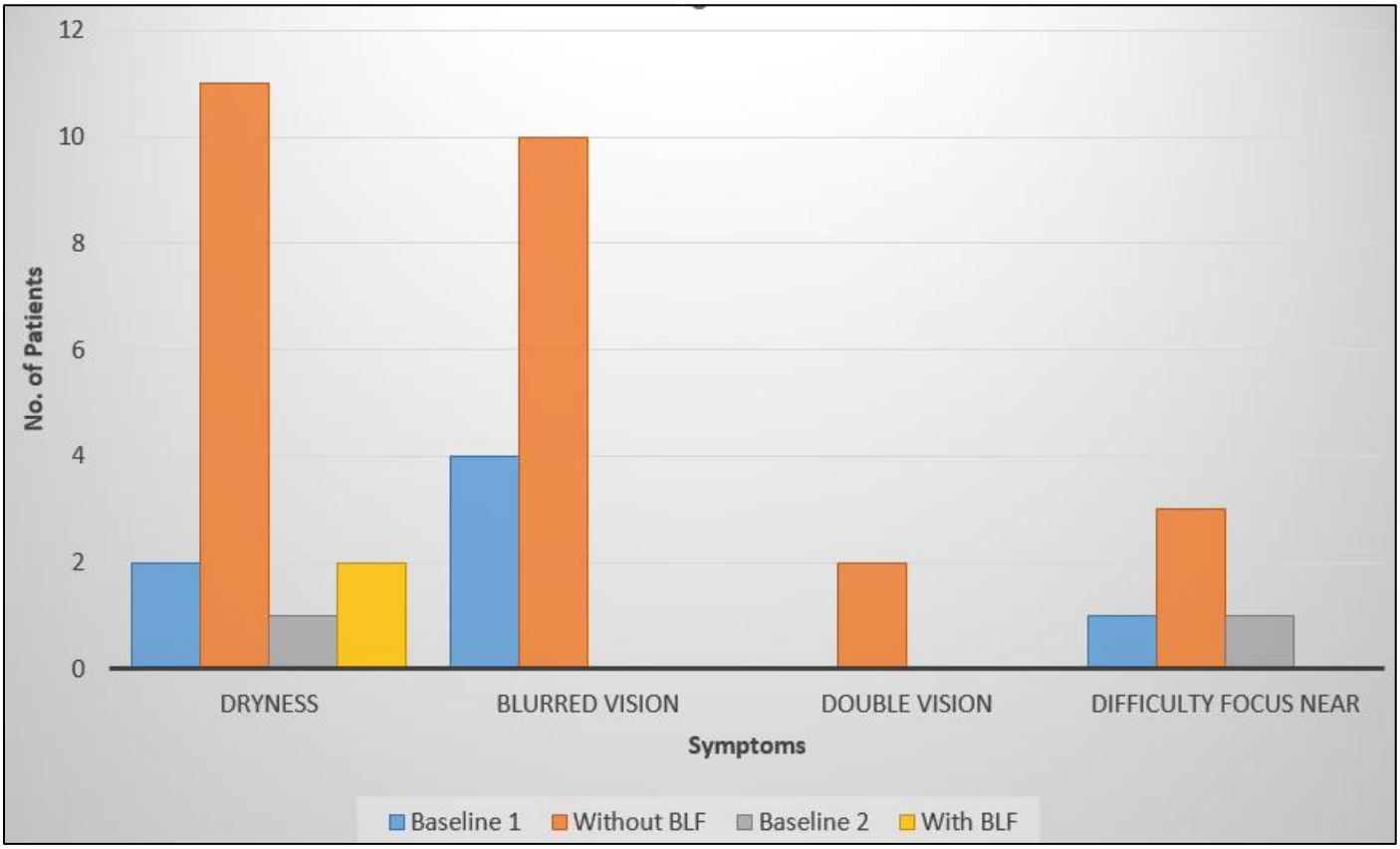

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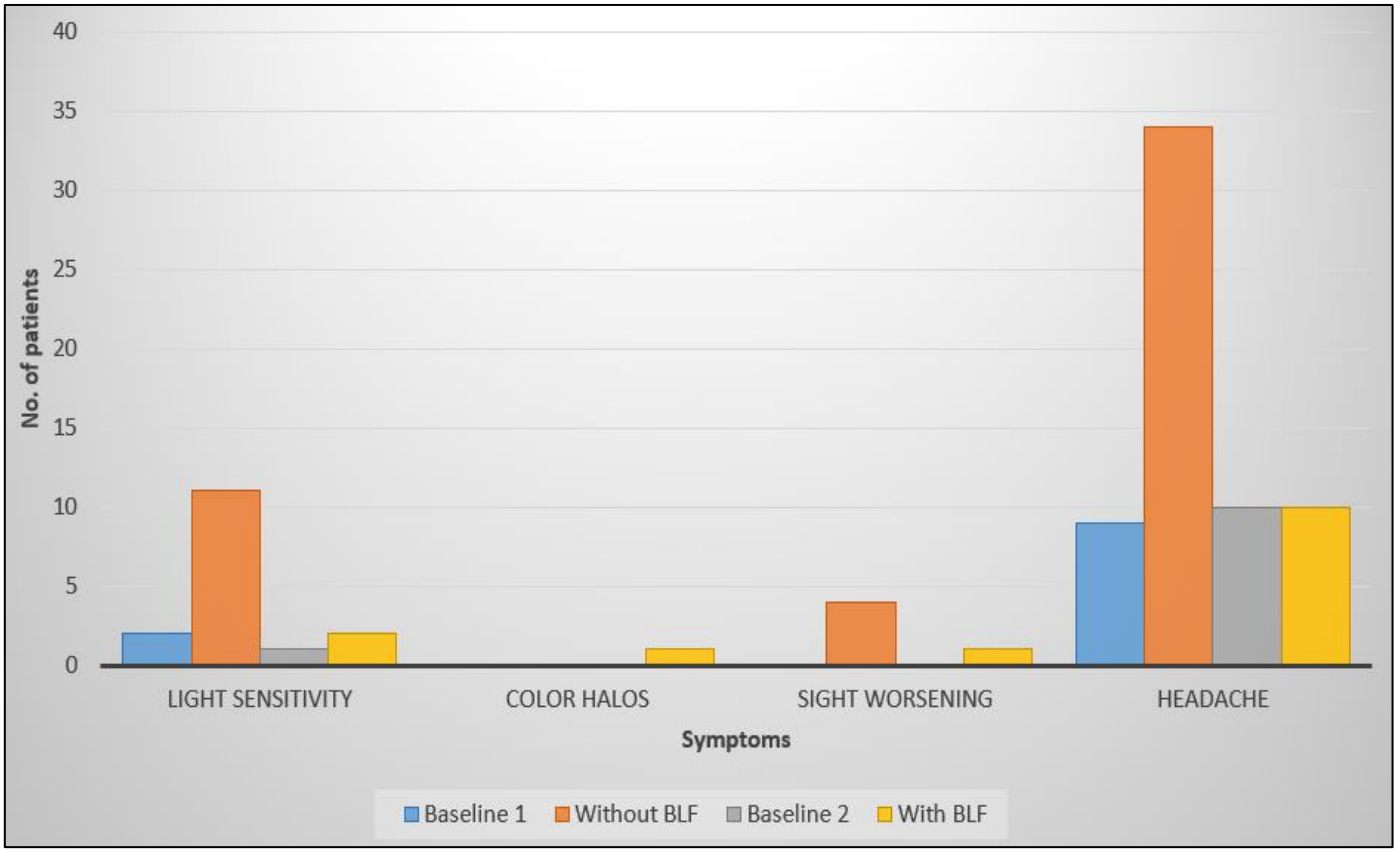

(d)

Fig 25 (a,b,c,d): Comparison of Symptoms with Conditions and Patients

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- *Interpretation:*

The values of symptoms under four distinct conditions—Baseline Day-1, Baseline Day-2, and with and without a blue light filter lens—are compared in the bar plot. From plot (a) the highest number of patients (23) were observed in burning sensation in consideration to "without BLF" condition and lowest (0) number of patients were observed in the "Baseline 1" condition of F.B. sensation. From plot (b) the highest number of patients (23) were observed in eye pain condition in consideration to "without BLF" condition and zero number of patients were observed in the "Baseline 2" condition of Excessive blinking symptom. From plot (c) the highest number of patients (11) were observed in dryness symptom in consideration to "without BLF" condition and most of patients were decreased with symptoms in the "Baseline 1", "Baseline 2" and "with BLF" conditions of blurred vision, double vision and difficulty focus near symptoms. From plot (d) the highest number of patients (34) were observed in headache symptom in consideration to all conditions and lowest number of patients were observed with "Baseline 1" and "Baseline 2" conditions of colour halos and sight worsening symptoms.

➢ *Statistical Test Results*

The Near Point of Accommodation (NPA) readings obtained with and without blue-light filter lenses for the right eye (OD), left eye (OS), and binocularly (OU) were compared using a paired sample t-test. A paired t-test was suitable because the measurements were taken from the same subjects both before and after they wore blue-light lenses.

➢ *Paired T-Test Results*

Table 7 Comparison of NPA Before and After Using Blue Light

Comparison		t-value	p-value	Interpretation
NPA (cms)	OD	1.76	0.085	Not statistically significant
	OS	2.14	0.038	Statistically significant
	OU	1.10	0.279	Not statistically significant

- *Interpretation:*

The findings show that using blue-light filter lenses did not significantly alter NPA measures for the right eye (OD) or binocular vision (OU) when compared to not wearing them ($p > 0.05$). This implies that accommodative performance under those circumstances was not significantly affected by wearing blue-light filter lenses. The difference was found to be statistically significant ($p = 0.038$) for the left eye (OS), indicating that blue-light filter lenses had a discernible impact on the left eye's accommodative demand. Mean values determine whether the change is improving or getting worse, although statistically, the lens only had an impact on OS.

Overall, under all circumstances, the accommodative capacity was not consistently or significantly altered by the blue-light filter lenses. The right eye and binocular measures did not change; only the left eye displayed a statistically significant difference. These results imply that the effect of blue-light lenses on NPA measures may be negligible or variable.

Table 8 Comparison of AF Before and After Using Blue Light

Comparison		t-value	p-value	Interpretation
AF (cms)	OD	6.92	<0.001	Statistically significant
	OS	5.81	<0.001	Statistically significant
	OU	6.45	<0.001	Statistically significant

- *Interpretation:*

Accommodative facility (AF) values for right eye (OD), left eye (OS), and binocular vision (OU) were compared before and after wearing blue light filter lenses using a paired t-test analysis. In all three testing situations, the results show a statistically significant improvement. The improvement in accommodative capacity for the right eye was extremely significant ($p < 0.001$), suggesting that utilizing lenses increased focusing speed. Likewise, there was a substantial rise ($p < 0.001$) in the left eye as well. With a significant p-value (<0.001), the binocular measures demonstrated the greatest functional gain, indicating increased efficiency when both eyes cooperated. Overall, the findings confirm that accommodative function is positively impacted by blue light filter lenses.

Table 9 Comparison of NPC Before and After Using Blue Light by T-Test

Measure (NPC in cm)	Condition	Mean (cm)	SD (cm)
Break	With	6.10	0.93
	Without	6.04	1.02
Recovery	With	9.47	1.26
	Without	9.38	1.14

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

- *Interpretation:*

The Near Point of Convergence (NPC) mean and standard deviation values under two scenarios with and without blue light filter lenses are shown in the table. The mean value for the NPC Break point improved somewhat from 6.04 cm (without lens) to 6.10 cm (with lens). Since greater NPC values indicate poorer convergence, this slight rise suggests a slight decrease in convergence ability when using blue-light lenses. Additionally, employing the lenses caused the variability (SD) to slightly reduce (from 1.02 cm to 0.93 cm), indicating more consistent responses with blue-light lenses. A similar pattern is shown for the NPC Recovery measure. Again, showing a minor decline in convergence recovery ability while using the lenses, the mean recovery distance increased slightly from 9.38 cm (without lens) to 9.47 cm (with lens). Under the blue-light condition, the standard deviation increased significantly (from 1.14 to 1.26 cm), indicating a modest increase in response variability.

Overall, the results indicate that wearing blue light filter lenses only slightly increased the NPC break and recovery values. This implies that convergence performance may be barely affected by blue light filtering lenses, possibly making convergence marginally less effective. Nonetheless, there aren't many clinically significant differences between the two disorders. To ascertain whether these observed differences are statistically significant, additional inferential statistics (such paired t-tests) would be required.

Table 10 Statistical Analysis Table of Comparison of VF

Sl. No.	Conditions	Comparison	Test Statistic	p-value	Interpretation Result
1	Baseline	Day 1	Paired t-test (4.08)	<0.001	Statistically Significant
		Day 2			
2	BLF (without and with)	Day 1	Paired t-test (4.22)	<0.001	Statistically Significant
		Day 2			

- *Interpretation: 1.*

The Vergence facility on Day 1 and Day 2 was compared among 48 participants using a paired t-test. A paired samples t-test is applied to compare From, Day 1 (M = 14.87 cpm, SD = 2.13) to Day 2 (M = 15.10 cpm, SD = 2.16), the results demonstrated a statistically significant improvement (t (47) = 4.08, p <.001).

Vergence facility performance increased slightly but statistically significantly between baseline and Day 2, with an average improvement of 0.23 cpm. Vergence facility has significantly improved between Day 1 and Day 2. Despite being statistically significant, the effect size is tiny, indicating the improvement may not be clinically meaningful, it may indicate repeated testing.

The vergence capacity of 48 participants with and without blue light filter lenses was compared using a paired-samples t-test. When compared to no blue light filter (M = 15.16, SD = 2.36), there was a statistically significant improvement in vergence facility when using blue light filter lenses Mean=15.91, SD=2.37, t=4.22. The use of blue light filter lenses may improve vergence facility performance, as seen by the average improvement of 0.75 cycles per minute (cpm). There is a statistically significant improvement. The result is significant, indicating that blue light-filtering glasses could improve vergence tasks' visual processing time.

Table 11 Statistical Analysis Table of Comparison of AC/A Ratio

Sl. No.	Conditions	Comparison	Test Statistic	p-value	Interpretation Result
1	Baseline	Day 1	Wilcoxon Sign- rank test (W=6)	0.42	Not Statistically Significant
		Day 2			
2	BLF (without and with)	Day 1	Wilcoxon Sign- rank test (W=10)	0.31	Not Statistically Significant
		Day 2			

- *Interpretation: 1.*

The 48 participants of baseline Day 1 and Day 2, AC/A ratios were compared using a Wilcoxon Signed-Rank test. The two time points did not differ statistically significantly (W = 6, p = 0.42). The AC/A ratio was steady between sessions and unaffected by short-term measurement or adaptation effects, as seen by the bulk of measurements being unchanged. From Day 1 to Day 2, the AC/A ratio stayed steady and constant. There is no proof of measurement variability, learning impact, or change.

The total 48 individual's AC/A ratio results with and without blue light filter lenses were compared using a Wilcoxon Signed-Rank test. There was no statistically significant difference between the two circumstances according to the test (W = 10, p = 0.31). The bulk of AC/A values did not change, suggesting that the AC/A ratio was unaffected by the use of blue light filter lenses. Because of the blue light filter lenses, the AC/A ratio remains constant. Short-wavelength light filtering seems to have no effect on the AC/A process, which seems to be physiologically consistent.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER FIVE
DISSCUSION

➢ *Disscusion*

- Our study found that Near point of Accommodation (NPA) has increased in both without BLFLs and with BLFLs while using laptop whereas the study of Ugam P. S. U. et al,published in 2023 shows NPA has decreased significantly after using digital devices.

- Our study shows that symptoms like burning sensation, excessive blinking, heavy eyelids, difficulty focus near were reduced after using BLFLs than compared without use of BLFLs while doing digital task meanwhile the study of Alexander D, published in 2019 showed that this symptoms were slightly increased.

- In the study of Alexander D, published in 2019, it was observed that symptom of headache was not influenced both with BLFLs and without BLFLs where as in our study headache is significantly reduced after using BLFLs while using laptop.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER SIX
CONCLUSION

- *Conclusion*

This study demonstrates that short-term use of blue light filter lenses (BLFL) during laptop-based tasks leads to measurable improvements in visual function. A modest enhancement in accommodative parameters and slight improvement in vergence performance indicate reduced visual load when blue-light exposure is minimized. Participants also reported a clear reduction in visual discomfort, showing that BLFL lessen acute digital eye strain. Overall, BLFL act as an effective, non-invasive optical aid that supports more stable accommodative and binocular responses while improving visual comfort during short-duration laptop use. So thereby, we would like to conclude that use of BLFLs for regular use is beneficial for those who use prolonged digital devices as it will reduce eye strain and improve comfort.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

CHAPTER SEVEN
LIMITATION

➢ *Limitation*

- This study measures immediate/acute effect (1 hour) of BLFLs, which may not reflect how BLFLs affect the visual system during prolonged or repeated use.
- Participant for the study were included from the Convenience sampling method(student, hospital patient).So, it limits the generalization of results to wider age group and broader population.
- The study includes only emmetropes. So, the study lacks data about effect of BLFL on Ammetropes.
- Participants were restricted to young adults aged 18–30 years. The results may not be generalizable to children, teenagers, or older adults whose accommodation and vergence responses differ.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

FUTURE SCOPE

➢ *Future Scope*

- In future, this research can be conduct over week or months, rather than a short-term task to evaluate effect of BLFLs on vergence,accommodation and digital eye strain.
- In future, this research can be performed in ammetropes also with the BLF in their refractive correction.
- Future research can include larger sample size across diverse populations which could improve the generalizability of the findings.
- Future study can evaluate how blue light filters used during evening laptop work influence sleep quality, circadian rhythm and overall visual performance the next day.
- Future study may analyzed whether blue light filters have any influence on task accuracy, reading speed, reaction time or overall cognitive workload during digital use.

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

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ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

ANNEXURES

ANNEXURE-I

Short term effect of blue light filter on vergence, accommodation and visual comfort in digital task using laptop: A Questionnaire based Prospective Analysis Study

Patient consent to take part in research

I.....Voluntarily agree to participate in this research study.

I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.

I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.

I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.

I understand that participation involves performing a procedure for Short term effect of blue light filter on vergence, accommodation and visual comfort in digital task using laptop : a Prospective experimental study.

I understand that I will not benefit directly from participating in this research.

I understand that all information I provided for this study will be treated confidentially.

I understand that in any report on the result of this research my identity will remain anonymous.

I understand that if I inform the researcher that myself or someone else is at risk of harm, they may have to report this to the relevant authorities – they will discuss this with me first but may be required to report with or without my permission.

I understand that signed consent forms and data will be retained safely until the study is over.

I understand that under freedom of information legalization I am entitled to access the information I have provided at any time while it is in storage as specified above.

I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Name: Miss. Bachan Chaudhary & Mr. Bishal Bhujel

UNIVERSITY: Under affiliation RAJIV GANDHI UNIVERSITY OF HEALTH SCIENCE

COLLEGE NAME: SHRIDEVI INSTITUTE OF ALLIED HEALTH SCIENCES

GUIDE: Mrs. A.P Nishand begum, Lecturer, Dept. of Optometry, SIAHS, Tumkur

Signature of research participant:

....

Signature of participant Date

Signature of researcher:

I believe the participant is giving informed consent to participate in this study

_____ _____

Signature of researcher Date

_____ _____

Signature of researcher Guider signature

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

ANNEXURE-II

PROFOMA

Demographic Data:

NAME: AGE/GENDER:

CONTACT NO.: COURSE:

History:

CHIEF COMPLAIN	
OCULAR HISTORY	
SYSTEMIC HISTORY	
MEDICAL HISTORY	
FAMILY HISTORY	
SOCIAL HISTORY	

Visual Acuity:

Eye	DISTANCE VISION @ 4m (Unaided)	NEAR VISION @ 40cm
OD		
OS		
OU		

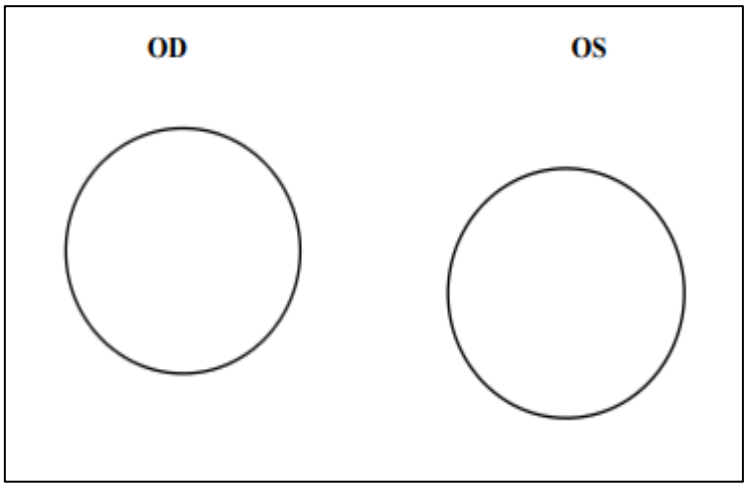
Ishihara Color Vision Test (38 Plates):

Eye	Plates
OD	
OS	

Slit Lamp Examination:

EYE	OD	OS
EYELID		
CORNEA		
CONJUCTIVA		
SCLERA		
PUPIL		

Fundus Examination: (Direct Ophthalmology)



ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

OD	FUNDUS FINDING	OS
	CUP DISC RATIO	
	AV RATIO	
	FOVEAL REFLEX	
	MACULA	
	VITREOUS	
	PERIPHERY	

Test Performed:

Acommodation parameters		Baseline			Without BLFL			
	R1	R2	R3	Mean	R1	R2	R3	Mean
NPA (in cm)	OD							
	OS							
	OU							
Accomodative facility (in cpm)	OD							
	OS							
	OU							

Vergence parameters		Baseline			Without BLFL			
	R1	R2	R3	Mean	R1	R2	R3	Mean
NPC (in cm)	Break							
	Recovery							
Vergence facility (in cpm)								

AC/A Ratio (Heterophoria Method)	Baseline	Without BLFL

Acommodation parameters		Baseline			With BLFL			
	R1	R2	R3	Mean	R1	R2	R3	Mean
NPA (in cm)	OD							
	OS							
	OU							
Accomodative facility (in cpm)	OD							
	OS							
	OU							

Vergence parameters		Baseline			With BLFL			
	R1	R2	R3	Mean	R1	R2	R3	Mean
NPC (in cm)	Break							
	Recovery							
Vergence facility (in cpm)								

AC/A Ratio (Heterophoria Method)	Baseline	With BLFL

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

ANNEXURE-III

QUESTIONNAIRE

TITLE: SHORT TERM EFFECT ON VERGENCE, ACCOMODATION AND VISUAL COMFORT IN DIGITAL TASK USING LAPTOP

Questionnaire based on computer vision syndrome by ARNE AARAS.

Participant name: Age/Gender:

Signature:

INSTRUCTIONS: Respond to each of the following categories,put a tick mark based on the severity.

Do you notice any of the following symptoms affecting you right now?

1. Burning

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

2. Itching

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

3. Foreign body sensation

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

4.Tearing

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

5. Excessive blinking

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			

6. Eye redness

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

7. Eye pain

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

8.Heavy eyelids

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

9.Dryness

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

10.Blurred vision

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

11.Double vision

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

12Difficulty focusing near

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

13.Sensitivity to light

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

14.Colored halos

		not noticeable at all “0”	somewhat noticeable “1”	extremely noticeable “2”
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

15.Sight worsening

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26jan384

		not noticeable at all "0"	**somewhat noticeable "1"**	**extremely noticeable "2"**
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			

16.Headache

		not noticeable at all "0"	**somewhat noticeable "1"**	**extremely noticeable "2"**
Day -1	Baseline			
	Post laptop without BLFL			
Day -2	Baseline			
	Post-laptop with BLFL			