



## Utilization of Low Vision Aids in Achromatopsia

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### Abstract

**Background:** Achromatopsia, a rare genetic disorder, results in complete or near-complete color blindness, impacting visual perception and causing associated challenges such as reduced visual acuity, light sensitivity (photophobia), and involuntary eye movements (nystagmus). Low vision aids play a pivotal role in mitigating these challenges, aiming to enhance visual acuity, alleviate photophobia, and facilitate daily activities for individuals with achromatopsia. This study investigates the utilization and effectiveness of various low vision aids tailored to address the specific needs of individuals with achromatopsia.

**Methodology:** A prospective cross-sectional study was conducted over a period of three years in several blind schools in Gujarat, India. Enrollment criteria included informed consent, achromatopsia diagnosis, and categorization under low vision. The study utilized assessments for visual acuity, contrast sensitivity, and color vision. Participants were prescribed low vision aids such as spectacle filters, tinted lenses, telescopic systems, handheld electronic magnifiers, and head-mounted electronic devices based on their individual requirements. A three-month training program was provided to ensure proficient use of the prescribed aids. Data analysis was performed using SPSS software and Microsoft Excel, and the results were analyzed and interpreted accordingly.

**Results:** The study included 39 subjects with achromatopsia. Tinted lenses, particularly in yellow and red tints, were found to alleviate photophobia and improve visual acuity and contrast sensitivity. Spectacle-mounted devices and handheld electronic magnifiers were widely utilized by the participants, showcasing improvements in distance viewing and reading abilities. Electronic low vision aids, specifically head-mounted devices with cameras, demonstrated potential in enhancing visual acuity and facilitating various tasks, enabling greater independence and efficiency.

**Conclusion:** Low vision aids, including personalized tinted lenses and electronic devices, have proven to be instrumental in ameliorating the visual challenges faced by individuals with achromatopsia. Spectacle filters and tinted lenses significantly alleviate photophobia and improve visual function. Electronic aids, offering real-time magnification and adjustable contrast settings, display promise in enhancing visual acuity and promoting greater independence in daily activities. A tailored approach, considering individual preferences and needs, coupled with comprehensive rehabilitation and support, maximizes the effectiveness of low vision aids. Continued research and technological advancements are crucial to developing specialized low vision aids for achromatopsia, further enhancing the quality of life for affected individuals.

**Keywords:** Achromatopsia; Low Vision Aids; Visual Acuity; Photophobia; Electronic Magnifiers; Tinted Lenses; Contrast Sensitivity; Head-Mounted Devices; Quality of Life

## Introduction

Achromatopsia is a rare genetic disorder that affects the visual system, leading to complete or near-complete color blindness. Individuals with achromatopsia have impaired or absent function of cone photoreceptors, which are responsible for perceiving colors and providing high visual acuity in bright lighting conditions. This condition is typically present from birth and affects approximately 1 in 33,000 individuals worldwide. Achromatopsia is often associated with other visual impairments, including reduced visual acuity, extreme sensitivity to light (photophobia), and nystagmus (involuntary eye movements).

Achromatopsia poses significant challenges to individuals in their daily lives. The absence of functional cone photoreceptors leads to a reduced ability to discriminate fine details and perceive colors, resulting in decreased visual acuity. Furthermore, excessive light sensitivity can cause discomfort and pain, limiting exposure to bright environments and outdoor activities. The combination of these visual impairments significantly impacts the quality of life, educational opportunities, employment prospects, and social interactions of individuals with achromatopsia.

Low vision aids play a crucial role in mitigating the visual challenges faced by individuals with achromatopsia. These aids aim to improve visual acuity, reduce light sensitivity, enhance color perception, and support individuals in daily activities such as reading, writing, and navigating the environment. Low vision aids encompass a wide range of optical, electronic, and assistive technologies designed to compensate for the limitations imposed by achromatopsia. They aim to improve visual function, enhance independence, and promote participation in various aspects of life.

Despite the progress made in developing low vision aids, there is still a need for further research and development to address the specific needs of individuals with achromatopsia. This research paper provides a comprehensive review of the current state of low vision aids in achromatopsia, including optical devices, electronic devices, and assistive technologies.

## Methodology

A prospective, cross sectional study was performed at different blind schools of Gujarat within the period of 3 years. Subjects enrolled in this study are with informed consent. Subjects having Achromatopsia and falls under the criteria of low vision are enrolled in the study. Subjects who were below the low vision category and no pl vision were excluded from the study. Subjects having

any other systemic disease associated were also excluded from the study. Visual acuity was assessed with various Log Mar charts. Contrast Sensitivity was assessed with Hiding Heidi charts and colour vision was assessed with PV 16 (Precision vision colour).

Spectacle-mounted devices was provided with spectacle lenses equipped with high-powered magnifiers to enhance visual acuity for reading and other close-up tasks. Filtered lenses and tints were prescribed to reduce the intensity of light and alleviate photophobia symptoms. These lenses also provided increased contrast perception. Telescopic system was fitted with telescopic glasses to improve distance vision, which allows to recognize faces and objects from a greater distance. Prism glasses were prescribed to address nystagmus, minimizing involuntary eye movements and to stabilize vision.

Handheld electronic magnifiers with variable magnification levels and adjustable contrast settings was provided to assist with reading and viewing fine details. Head-mounted electronic devices which incorporate camera systems and display screens, providing real-time magnification and contrast enhancement for activities requiring both hands, such as writing and manual tasks. A desktop electronic reading system was also recommended, enabling to access and read printed materials, such as books and documents, with adjustable font sizes and color contrasts.

Devices were prescribed as per the need of the subjects. 3 month training by the experts were provided for handling and using the devices given. Wherever needed devices had also changed if not feasible to use by the subject. Follow up was taken after 3 months of successful use of the devices prescribed. Data was analysed using SPSS software and Microsoft office Excel 13.

## Results

39 subjects having Achromatopsia were enrolled in the study. Fig 1 shows distribution of subjects as per the age group. Fig 2 shows gender wise distribution of the subjects. Among the devices prescribed and used, The study shows that 2.1x See Tv was used by 69% of the total subjects for distance viewing. Tinted lenses were used by 93% of the subjects. The results showed that yellow and red tints provided significant relief from photophobia and improved visual acuity and contrast sensitivity in a majority of participants. Prism glasses was used by 48% while handheld electronic magnifiers with adjustable magnification and contrast level was used by 71% of the subjects.

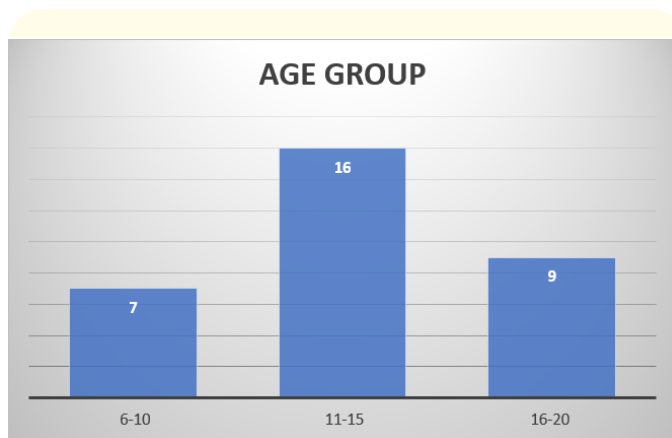


Figure 1: Shows distribution of subjects as per the age group.

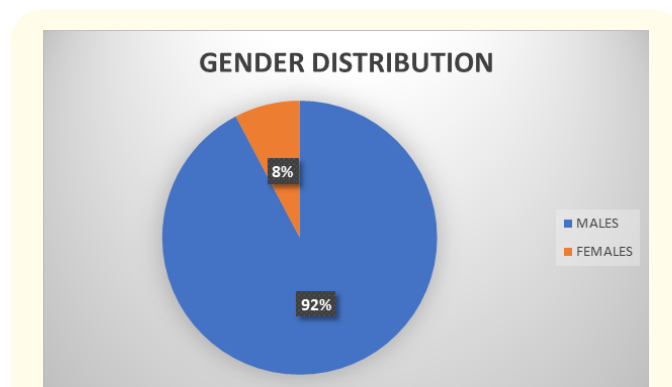


Figure 2: Gender wise distribution of subjects.

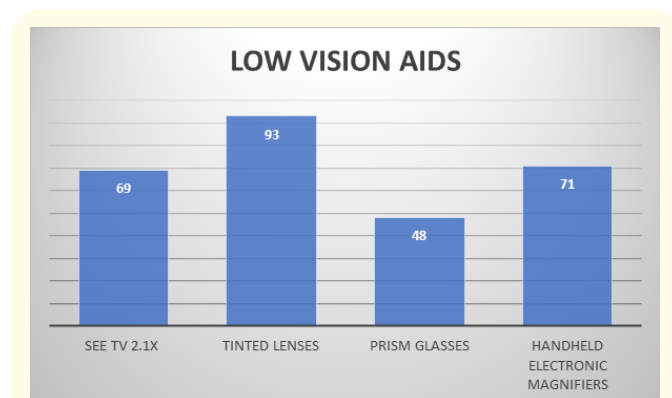


Figure 3: Shows percentage of usage of low vision aids.

### Discussion

Low vision aids play a crucial role in improving visual functioning and quality of life for individuals with achromatopsia.

Spectacle filters and tinted lenses are commonly prescribed to individuals with achromatopsia to alleviate photophobia and enhance contrast sensitivity. While these aids provide some relief, their impact on color vision and visual acuity is limited. Personalized tint selection and consideration of genetic variations in cone pigments are important factors to optimize their effectiveness.

Electronic low vision aids, including electronic magnifiers and head-mounted devices with cameras, show great promise in enhancing visual functioning for individuals with achromatopsia. These aids provide real-time magnification, adjustable contrast settings, and color enhancement options. They offer improved visual acuity and reading abilities, allowing individuals to engage in various tasks with greater independence and efficiency.

It is important to consider individual variability and preferences when prescribing low vision aids in achromatopsia. Each person’s visual needs and preferences may differ, and a personalized approach is essential for optimal outcomes. The use of low vision aids should be accompanied by comprehensive low vision rehabilitation, including training and support, to maximize their effectiveness.

Kommanapalli, *et al.* [1] studied, “Low Vision Rehabilitation for Achromatopsia: Spectacle Tinting, Filters, and Visual Performance. They investigated the efficacy of spectacle tinting and filters in improving visual performance for individuals with achromatopsia and found that tints provide relief from photophobia and improves visual function. Similarly in our study it is also found that subjects had adapted to red and yellow tints which significantly relieves from photophobia.

Rigi, *et al.* [2] studied, “Low Vision Rehabilitation in Achromatopsia: A Systematic Review” This systematic review examined the effectiveness of low vision rehabilitation interventions, including low vision aids, for individuals with achromatopsia. The study found that spectacle filters and tinted lenses provided some relief from photophobia, but their impact on color vision and visual acuity was limited. Telescopic devices were effective in improving distance vision, but they had certain drawbacks. Electronic low vision aids showed promise in enhancing visual functioning and quality of life for individuals with achromatopsia. Results of this study also matches the current study which says that visual functions had significantly improved with the use of low vision aids.

Further research and development in low vision aids specific to achromatopsia are needed. Advancements in technology, such as augmented reality and artificial intelligence, hold promise for future innovations in low vision aids, potentially further improving the visual capabilities and quality of life for individuals with achromatopsia [3-20].

## Conclusion

Low vision aids have proven to be valuable tools in mitigating the visual impairments associated with achromatopsia. By addressing specific challenges and improving visual functioning, these aids offer individuals with achromatopsia opportunities for greater independence, engagement, and overall well-being.

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