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ROLE OF LOW VISION AIDS IN THE ENHANCEMENT OF RESIDUAL DISTANCE AND NEAR VISUAL ACUITY IN PATIENTS WITH MACULAR DISEASE

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Abstract

Background: *Macular disease produces irreversible central vision loss with no curative treatment, so management relies on visual rehabilitation with low vision aids; however, local data on the acuity gain achievable across the spectrum of macular disease in Pakistan are scarce.*

Objectives: *To quantify the improvement in residual distance and near visual acuity achieved with low vision aids in patients with macular disease, and to identify the most effective devices.*

Methods: *In this cross-sectional study at a tertiary care eye hospital in Karachi, Pakistan, 31 patients with macular disease prescribed a low vision aid between August 2025 and January 2026 were enrolled. Best-corrected distance acuity (logMAR) and near acuity (M-notation) before and after provision of an aid were compared using the paired t-test and Wilcoxon signed-rank test.*

Results: *Median age was 13 years (range 6–58); 25 patients (80.6%) were male. Distance acuity ($n = 31$) improved from 0.99 ± 0.20 to 0.77 ± 0.28, a mean gain of 0.22 ± 0.17 ($p < 0.001$), improving in 28 patients (90.3%). Near acuity ($n = 21$) improved from 3.58 ± 1.46 M to 2.25 ± 1.13 M, a mean reduction of 1.33 ± 0.91 M ($p < 0.001$). Higher-magnification telescopes gave the largest distance gains; the illuminated handheld magnifier was the most effective near device.*

Conclusion: *Low vision aids produced a statistically significant improvement in both residual distance and near visual acuity in macular disease. Higher-magnification telescopes were most effective for distance and illuminated handheld magnifiers for near work, supporting routine low vision rehabilitation.*

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1. INTRODUCTION

The macula is the central region of the retina that subserves high-resolution central vision and is essential for reading, recognizing faces, driving, and most occupational tasks. Any disease that causes irreversible damage to this area produces a corresponding loss of central vision that cannot be restored by optical, medical, or surgical means.

Low vision is defined as a best-corrected distance visual acuity of less than 6/18 down to and including 3/60, or a visual field of less than 10 degrees from the point of fixation in the better eye, after all possible optical, medical and surgical correction. The macular diseases that most commonly cause low vision include age-related macular degeneration, diabetic maculopathy, macular scarring, Stargardt disease and other juvenile macular dystrophies, cone dystrophy and myopic (pathological) maculopathy.

Age-related macular degeneration is the leading cause of irreversible central vision loss in older adults worldwide. A pooled meta-analysis estimated the global prevalence of any age-related macular degeneration at 8.7%, projecting that the number of affected individuals would rise from 196 million in 2020 to 288 million by 2040, with a substantial share of this increase occurring in Asia.[1]

More recent modelling from the Global Burden of Disease programme confirms that the burden of vision impairment attributable to age-related macular degeneration continues to grow as populations age.[2] Although age-related macular degeneration predominates in older patients, in low- and middle-income settings such as Pakistan the low vision clinic also serves a substantial number of children and young adults with inherited and acquired maculopathies, in whom central vision loss has profound educational and vocational consequences.[3,4]

There is currently no satisfactory treatment that restores vision in atrophic age-related macular degeneration or in most inherited macular dystrophies; for early and intermediate age-related macular degeneration, antioxidant vitamin and mineral supplementation can slow progression but does not reverse established central vision loss, so management is ultimately centered on visual rehabilitation.[5,6,7] The inherited and acquired maculopathies seen in younger patients, including Stargardt disease and other ABCA4-related dystrophies, cone and cone-rod dystrophies, and myopic macular degeneration are likewise managed largely through magnification and rehabilitation rather than cure.[8,9,10,11] Low vision aids work principally by magnification, increased illumination and contrast enhancement, allowing the residual retina to be used more effectively. Telescopic systems magnify distant objects, while hand-held and stand magnifiers, high-addition spectacles and electronic systems assist with near tasks. A consistent body of evidence has shown that the provision of low vision aids significantly improves reading ability and reading speed in age-related macular degeneration,[12,13] and that simple optical magnifiers are often sufficient to restore functional reading.[14]

Much of the published literature, however, derives from high-income countries and concentrates on age-related macular degeneration and on reading speed rather than on the magnitude of acuity gain across the broad spectrum of macular disease seen in a developing-country clinic. Local data quantifying how much distance and near acuity can be recovered with the devices that are actually available, and which devices perform best, remain scarce. The present study was undertaken to address this gap.

2. MATERIALS AND METHODS

Study design and setting: This was a cross-sectional study conducted at the low vision clinic of Al-Ibrahim Eye Hospital in Karachi, Pakistan, over six months from August 2025 to January 2026. Each patient was assessed at a single visit, at which best-corrected visual acuity was recorded both before and with the low vision aid. The study was approved by the Research Ethical Committee of Al-Ibrahim Eye Hospital, Karachi (REC/IPIO/2025/098-A), and written informed consent was obtained from all participants or, in the case of minors, from their parents or guardians; the work adhered to the principles of the Declaration of Helsinki.

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Sampling:
A non-probability, purposive sampling technique was used. Thirty-one patients who presented to the low vision clinic between August 2025 and January 2026 and who met the eligibility criteria were enrolled.

Eligibility criteria:
Patients of any age who were diagnosed with any macular disease and who were trialled or prescribed any optical low vision aid were included. Patients with a best-corrected distance visual acuity worse than 1/60, those with significant media opacity (cataract, corneal scarring, or vitreous haze), amblyopic eyes, and uncooperative or mentally unwell patients were excluded.

Data collection:
Data were recorded prospectively on a structured proforma. Recorded variables were age, sex, diagnosis, best-corrected distance visual acuity and near visual acuity in the better eye before and after the provision of a low vision aid, and the type and magnification of the device used for distance and for near. Distance acuity was recorded in logarithm of the minimum angle of resolution (logMAR) and near acuity in M-notation. Lower values denote better acuity for both scales; an improvement is therefore represented by a reduction in the value.

Statistical analysis:
All eligible patients presenting to the low vision clinic during the study period were enrolled as a consecutive convenience sample. Data were analysed using IBM SPSS Statistics version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation, or as median (range) where the distribution was skewed, and categorical variables as frequencies and percentages. The improvement in distance acuity (logMAR) and near acuity (M-notation) was calculated for each patient. Pre- and post-aid acuities were compared using the paired t-test, with the non-parametric Wilcoxon signed-rank test applied as confirmation given the small sample size. Mean improvement was also computed separately for each category of device; because the number of patients in some device categories was very small, these per-device means are presented descriptively only and were not subjected to formal statistical comparison. A p-value below 0.05 was considered statistically significant.

Use of artificial intelligence:
No generative artificial intelligence tool was used in the design, conduct, data analysis, or interpretation of this study, nor in the preparation of this manuscript.

3. RESULTS

Demographic and clinical characteristics:
Thirty-one patients were included. Age was right-skewed (skewness 1.70; Shapiro–Wilk $p < 0.001$), the median was 13 years (range 6–58 years; interquartile range 10–19), and 21 patients (67.7%) were younger than 18 years. Twenty-five patients (80.6%) were male and six (19.4%) were female. The commonest diagnoses were Stargardt disease (8 patients, 25.8%) and congenital maculopathy (7 patients, 22.6%), followed by macular scar and Bull's-eye maculopathy (4 patients each, 12.9%) and age-related macular degeneration (3 patients, 9.7%). The remaining diagnoses were macular dystrophy (2 patients) and cone dystrophy, pathological myopia, and macular atrophy (1 patient each). The distribution of diagnoses is shown in Table 1. Distance acuity was assessable in all 31 patients and near acuity in 21 patients; near acuity could not be reliably assessed in the remaining patients.

Table 1. Distribution of macular diagnoses among the study patients (n = 31).

Diagnosis	Number of patients	Percentage (%)
Stargardt disease	8	25.8
Congenital maculopathy	7	22.6
Macular scar	4	12.9

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Diagnosis	Number of patients	Percentage (%)
Bull's-eye maculopathy	4	12.9
Age-related macular degeneration	3	9.7
Macular dystrophy	2	6.5
Cone dystrophy	1	3.2
Pathological myopia	1	3.2
Macular atrophy	1	3.2
Total	**31**	**100.0**

Improvement in distance visual acuity:
Among the 31 patients with assessable distance vision, mean best-corrected distance acuity improved from 0.99 ± 0.20 logMAR (approximately 6/60 Snellen equivalent) before the aid to 0.77 ± 0.28 logMAR (approximately 6/36) with the aid. The mean improvement was 0.22 ± 0.17 logMAR (95% confidence interval 0.16–0.28). This improvement was highly statistically significant (paired $t = 7.22$, $p < 0.001$; Wilcoxon signed-rank test, $p < 0.001$). Distance acuity improved in 28 of 31 patients (90.3%), and 12 patients (38.7%) gained two lines or more (≥0.20 logMAR).

Improvement in near visual acuity:
Among the 21 patients with assessable near vision, mean near acuity improved from 3.58 ± 1.46 M before the aid to 2.25 ± 1.13 M with the aid. The mean reduction of 1.33 ± 0.91 M (95% confidence interval 0.92–1.75) was highly statistically significant (paired $t = 6.70$, $p < 0.001$; Wilcoxon signed-rank test, $p < 0.001$). Expressed as lines on the near chart, patients gained a mean of 2.1 ± 1.4 lines, with individual gains ranging from one to six lines. The pre- and post-aid acuities are summarised in Table 2.

Table 2. Visual acuity before and after the provision of low vision aids.

Measure	n	Before aid (mean ± SD)	With aid (mean ± SD)	Mean improvement	p-value
Distance acuity (logMAR)	31	0.99 ± 0.20	0.77 ± 0.28	0.22 ± 0.17	< 0.001
Near acuity (M-notation)	21	3.58 ± 1.46	2.25 ± 1.13	1.33 ± 0.91	< 0.001

Devices used and their effectiveness for distance:
The telescopic systems prescribed for distance were a low-power (1.5×) telescope (Vistaview; 14 patients), Keplerian telescope (9), Galilean telescope (4), clip-on telescope (2), and spectacle-mounted telescope (2). The greatest mean improvement was obtained with the clip-on telescope (0.36 logMAR), Keplerian telescope (0.32 logMAR), spectacle-mounted telescope (0.31 logMAR) and Galilean telescope (0.31 logMAR), all of which provided moderate-to-high magnification. The low-power 1.5× Vistaview telescope produced the smallest mean gain (0.10 logMAR), consistent with its lower magnification. These per-device means are descriptive and based on small numbers (as few as two patients per device), and should be interpreted with caution. The mean improvement achieved with each distance device is shown in Figure 1.

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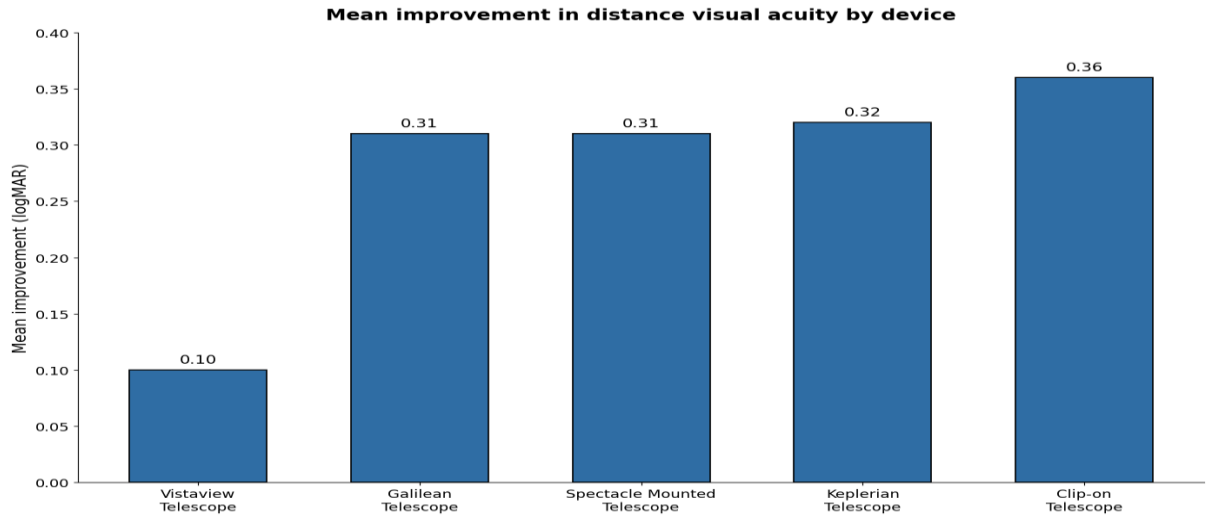


Figure 1. Mean improvement in distance visual acuity (logMAR) by type of telescopic device.

Devices used and their effectiveness for near: For near tasks, the devices used were the handheld magnifier (10 patients), illuminated handheld magnifier (6), and a high-addition (+4.00 dioptre) reading spectacle (5). The illuminated handheld magnifier produced the largest mean improvement (3.0 lines), followed by the high-addition spectacle (2.4 lines) and the non-illuminated handheld magnifier (1.5 lines). The superior performance of the illuminated magnifier is consistent with the additional benefit of enhanced retinal illumination in macular disease. The mean improvement achieved with each near device is shown in Figure 2.

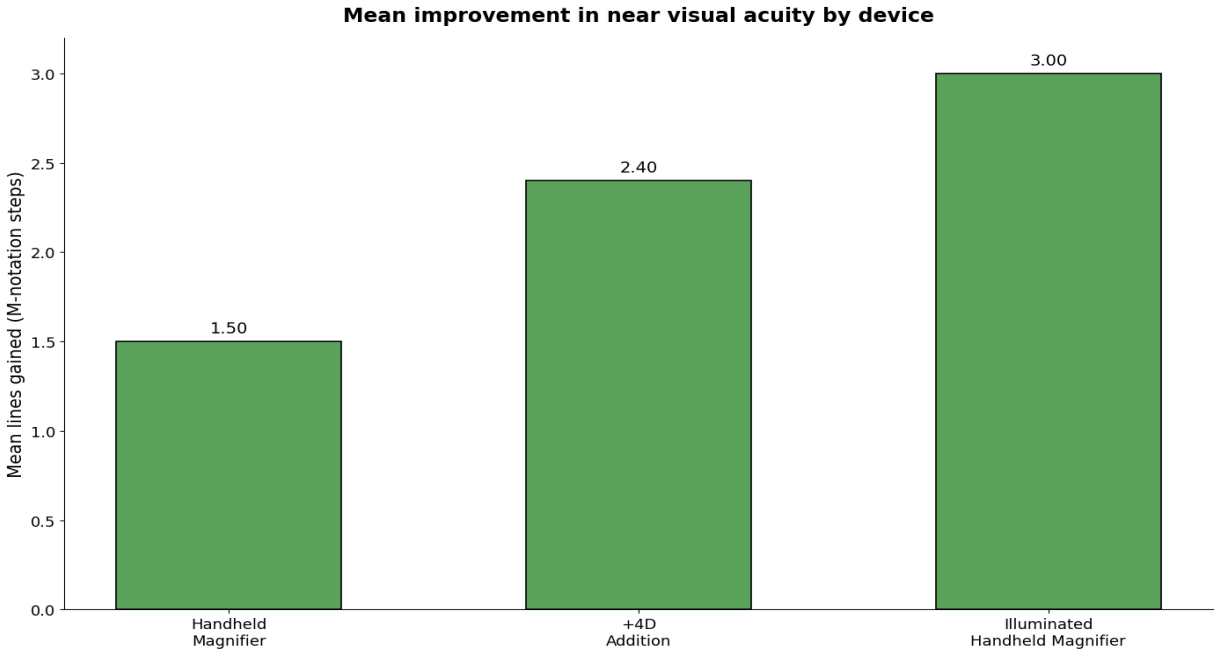


Figure 2. Mean improvement in near visual acuity (lines gained on the near chart) by type of near device.

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4. DISCUSSION

This study demonstrates that low vision aids produce a statistically significant and clinically meaningful improvement in both residual distance and near visual acuity across the spectrum of macular disease seen in a tertiary care clinic in Pakistan. Distance acuity improved in over 90% of patients, with a mean gain of 0.22 logMAR, while near acuity improved by a mean of 1.33 M-units, equivalent to more than two lines on the near chart. Both improvements were highly significant and were confirmed by a non-parametric test.

These findings are consistent with the international literature. Nguyen and colleagues reported that the provision of low vision aids increased mean reading speed from 20 to 72 words per minute in patients with age-related macular degeneration, and restored reading ability in 94% of patients.[12] Virtanen and Laatikainen found that 91% of patients with age-related macular degeneration could read newsprint after fitting a low vision aid, most often with a simple magnifier.[14] A systematic review and meta-analysis likewise concluded that low vision rehabilitation significantly improves reading performance relative to baseline in age-related macular degeneration,[13] and a Cochrane review found that magnifying reading aids, particularly stand-mounted electronic devices, improve reading performance in adults with low vision.[15] Studies using standardized reading charts have similarly shown that optical and electronic aids improve near acuity in age-related macular degeneration, although optical correction alone may be insufficient to maximize reading speed without additional rehabilitation.[16] Our results extend these observations by quantifying the gain in measured acuity, rather than reading speed, and by including a predominantly young population with inherited maculopathy.

The demographic profile of our sample differs markedly from the older populations of most published series, reflecting the case mix of a developing-country low vision service in which Stargardt disease and congenital maculopathy were the commonest diagnoses. Inherited retinal dystrophies are a leading cause of visual impairment in children and working-age adults, with Stargardt disease the most common inherited macular dystrophy.[9,17] This is clinically important because inherited macular dystrophies typically present in childhood or early adulthood, when central vision is needed for education and employment, and these patients often derive considerable benefit from magnification.[4,10,18] Case-based and series data in Stargardt disease have similarly shown that telescopes improve distance acuity and that magnifiers and high-addition spectacles support near work,[18,19] while myopic macular degeneration represented in our sample is an increasingly recognized cause of central visual loss, particularly in Asian populations.[8]

With regard to device selection, the higher-magnification telescopes (Keplerian, Galilean, clip-on, and spectacle-mounted) outperformed the low-power 1.5× Vistaview telescope for distance, while the illuminated handheld magnifier was the most effective near device. The advantage of illumination is expected, because patients with macular disease commonly require both magnification and increased contrast and luminance to use their residual retina effectively. These findings reinforce the principle that the choice and power of the device should be matched to the individual's magnification requirement and task, rather than applying a single device to all patients.

From a public health perspective, low vision rehabilitation remains under-utilised in Pakistan, where awareness of optical aids is limited, and access to services is uneven.[20,21] Given that there is no curative treatment for most of the conditions in this study, the demonstrable acuity gains reported here support the routine and early integration of low vision rehabilitation into ophthalmic care.

Limitations:

Functional outcomes such as reading speed, duration of device use, and quality of life were not captured, and validated vision-related quality-of-life and functional instruments would strengthen future work;[22] long-term adherence was also not assessed, and previous work suggests that sustained use and patient satisfaction are

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important determinants of real-world benefit.[23] The sample was small and predominantly young, with most patients younger than 18 years; subjective visual acuity measurement is less reliable in young children, and the per-device subgroups were too small for formal comparison, so the device rankings should be regarded as exploratory. Prospective, multicenter studies with larger samples and functional and quality-of-life endpoints are needed to confirm and extend these findings.

CONCLUSION

Low vision aids produced a statistically significant improvement in both residual distance and near visual acuity in patients with macular disease. Higher-magnification telescopic systems were most effective for distance vision, and illuminated handheld magnifiers were most effective for near vision. Because the underlying macular conditions are largely irreversible, these results support making low vision assessment and device prescription a routine component of the management of macular disease, including in young patients with inherited maculopathy.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Research Ethical Committee of Al-Ibrahim Eye Hospital, Karachi (REC/IPIO/2025/098-A). It was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent to participate was obtained from all participants, or from a parent or legal guardian in the case of minors.

CONSENT FOR PUBLICATION

Written informed consent for publication of clinical details was obtained from all participants, or from a parent or legal guardian in the case of participants under 18 years of age. No individually identifiable images or personal data are included in this manuscript.

AUTHOR'S CONTRIBUTION

H.P. conceived and designed the study. M.N.A and A.H.T. performed data collection and clinical assessment. H.P. and A.B carried out the statistical analysis and interpretation of data. N. and S.G. drafted the manuscript. H.P., M.N.A., and A.H.T. critically revised the manuscript for important intellectual content. All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

AVAILABILITY OF DATA

The authors confirm that the data supporting the findings of this study are available within the article. Additional de-identified data are available from the corresponding author upon reasonable request.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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