VISION SCIENCE AND EYE HEALTH JOURNAL

RESEARCH

Effectiveness of Spectacle Correction for Children with Refractive Amblyopia in Surabaya

Authors:
Audia Salwadiva
Sawitri Boengas*
Jefman Efendi Marzuki

Affiliations:
Department of Ophthalmology, Faculty of Medicine, Universitas Surabaya, Surabaya, East Java, Indonesia.

Corresponding author:
Sawitri Boengas
sawitri1973@staff.ubaya.ac.id

Dates:
Received: 21 July 2025
Revised: 17 January 2026
Accepted: 16 February 2026
Published: 05 March 2026

DOI:
https://doi.org/10.20473/vsehj.v5i2.2026.46-51

Abstract

Introduction: Amblyopia is a condition characterized by decreased visual acuity in one or both eyes. This condition frequently occurs in children because at this stage, there is a critical period of visual development. Delayed treatment can lead to decreased or even permanent vision loss. **Purpose:** To determine the prevalence of refractive amblyopia in children and evaluate the effectiveness of spectacle correction on visual improvement in children aged 6-18 years diagnosed with refractive amblyopia. **Methods:** This was an observational analytic study with a retrospective cohort approach. The study included 29 subjects aged 6–18 years with refractive amblyopia. Visual acuity was assessed in subjects who met the inclusion criteria. Eyeglasses were prescribed and visual development was monitored. Best-corrected visual acuity (BCVA) was re-evaluated after one and six months of wearing glasses. **Results:** A total of 15,387 pediatric patients were screened, of whom 144 (0.94%) were diagnosed with refractive amblyopia. Twenty-nine subjects met the inclusion criteria. Significant improvements in visual acuity were observed at one month (P = 0.045) and six months (P = 0.002) after spectacle use. At one month, 37.5% of eyes improved by one line, while at six months, 31.8% showed similar improvement. The difference in effectiveness between one and six months was not statistically significant (P = 0.484). **Conclusions:** Spectacle correction alone is effective in improving visual acuity in children with refractive amblyopia.

Keywords: refractive error; amblyopia; spectacle correction

Introduction

Refractive errors are conditions caused by abnormalities in the eye's refractive power or axial length, leading to blurred vision. If left uncorrected, these conditions can lead to amblyopia.[1],[2] Amblyopia, or lazy eyes, is defined as reduced visual acuity caused by disrupted visual cortex development during early life.[3] The early stages of life represent a critical period due to the ongoing development of the visual system.[4],[5] Disruptions during this period may cause the retinas of both eyes to generate unequal action potentials, leading to impaired neural interaction due to asymmetrical visual input.[6] Delayed therapy may lead the visual cortex to choose the dominant eye, resulting in decreased visual function in the less dominant eye.[7] This condition may affect one or both eyes.[4] Amblyopia is classified into several types, including refractive amblyopia, strabismic amblyopia, and deprivation amblyopia.[7] Risk factors for amblyopia include uncorrected refractive errors, anisometropia, and strabismus.[8] Additional risk factors include premature birth and a maternal history of smoking during pregnancy.[9]

Amblyopia is one of the leading causes of vision loss in children worldwide, with a prevalence ranging from approximately 1% to 6%.[10],[11] Amblyopia affects approximately 1.36% of the global population. Amblyopia affects approximately 1.36% of the global population. However, one study conducted in Jakarta, Indonesia, reported a higher prevalence of 2.7% among school-aged children,

with all identified cases attributed to uncorrected refractive errors. Similar patterns have also been observed in studies from India and Singapore, where refractive amblyopia was found to be the most common form.[12] Comprehensive data on amblyopia prevalence in Indonesia remain limited due to the lack of centralized, systematic reporting.

Amblyopia is diagnosed when visual acuity in one or both eyes is determined to be less than 1.0 by standardized clinical evaluation.[6] Amblyopia in children is generally challenging to detect, as they have no prior reference for normal vision and therefore may not express any visual complaints. As a result, the condition is often discovered incidentally during routine visual examinations.[13] Delayed and inadequate treatment of amblyopia may lead to decreased visual acuity and, in severe cases, permanent vision loss.[14] According to data from the World Health Organization (WHO), approximately 1.3% to 3.6% of children diagnosed with amblyopia experience vision loss.[15] Spectacle correction is one of the treatment modalities aimed at improving visual acuity.[7]

Previous studies[16],[17] have demonstrated the effectiveness of spectacle correction in improving visual acuity in children with amblyopia. However, most of this evidence is restricted to the pediatric age group of 7 to 10 years and focuses primarily on short-term outcomes. Visual improvement has been shown to occur within the first 4 to 12 weeks of spectacle use, after which a plateau is commonly reported, leaving uncertainty regarding the potential benefits beyond this early treatment window. Meanwhile, emerging evidence of neuroplasticity in older children and adolescents suggests that visual improvement may still be achievable beyond the traditionally defined critical period.[18] Despite this, data on the prevalence of refractive amblyopia and the effectiveness of spectacle correction across a broader pediatric age range remain limited. Therefore, the present study addresses this gap by evaluating the prevalence of refractive amblyopia and assessing visual acuity improvement following spectacle correction in children with refractive amblyopia, providing further insight into the therapeutic potential of optical correction beyond previously studied age boundaries.

Methods

Selection of subjects

This analytic observational study employed a retrospective cohort design. The study population comprised children aged 6 to 18 years diagnosed with refractive amblyopia who attended the Ophthalmology Clinic at Husada Utama Hospital, Surabaya, East Java, Indonesia, between December 2021 and December 2024. Other amblyopia subtypes, including strabismic and deprivation amblyopia, were not included in this study.

Participants were recruited using a nonprobability sampling method, and secondary data were obtained from medical records. Subjects were eligible if they were newly diagnosed with refractive amblyopia during the study period and were prescribed spectacle correction for the first time. The one month follow-up visit was considered the initial assessment following the commencement of spectacle use.

Additional inclusion criteria included continuous spectacle wear with documented follow-up data at both one and six months, normal fundus examination findings, and no history of prior amblyopia treatment. Exclusion criteria were the presence of other ocular pathologies, such as cataract, ptosis, or glaucoma, as well as incomplete or illegible medical records.

The study protocol was approved by the Ethics Committee of Husada Utama Hospital Surabaya (09/KEP-RSHU/V/2024). All data were fully anonymized prior to analysis, and visual acuity outcomes were assessed for all included participants.

Refractive examination

Assessment of visual acuity was performed using a standard Snellen chart positioned at a distance of 6 meters under consistent lighting conditions. Each subject underwent monocular testing to determine uncorrected visual acuity, followed by a refraction. Initial refractive measurements were obtained with an autorefractor to estimate spherical and cylindrical errors, which served as a reference for manual refinement with trial lenses.

Best-corrected visual acuity (BCVA) was determined by subjective refraction with trial lenses. The final prescription for spectacle correction was based on the refined subjective findings, ensuring optimal correction for each individual.

According to the prescription, subjects were instructed to wear the spectacles consistently, and scheduled clinical evaluations were conducted at one and six months post-correction. At each visit, BCVA was reassessed to monitor progress.

Definition

Refractive amblyopia was defined operationally as reduced BCVA in one or both eyes, in the absence of any identifiable structural ocular abnormalities, where the decreased vision was attributable solely to uncorrected refractive error. In this study, amblyopia was diagnosed when BCVA was less than 1.0 on the Snellen chart, as documented in standardized clinical assessments in the medical records.[6]

Improvement in visual acuity was defined as a gain of at least one Snellen line in BCVA from baseline, prior to spectacle correction, representing a clinically meaningful response to optical treatment.

Table 1. Demographic and characteristics of study participants.

Variable	Amblyopia (N = 29)
Age	**med (min, max)**
8	(6, 18)
Age	**n (%)**
6 years	5 (17.2)
7 years	5 (17.2)
8 years	7 (24.1)
9 years	4 (13.8)
10 years	3 (10.3)
12 years	3 (10.3)
13 years	1 (3.4)
18 years	1 (3.4)
Gender	**n (%)**
Male	14 (48.3)
Female	15 (51.7)
Eye	**n (%)**
Unilateral	10 (34)
Bilateral	19 (66)

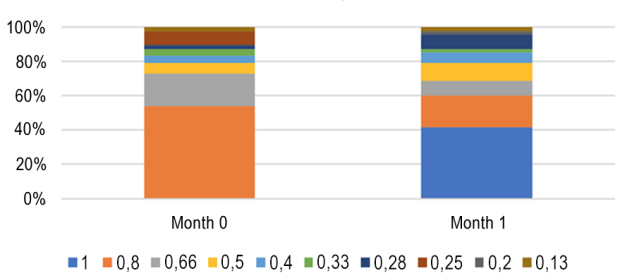

Figure 1. Comparison of visual acuity between baseline and one-month follow-up (N = 48).

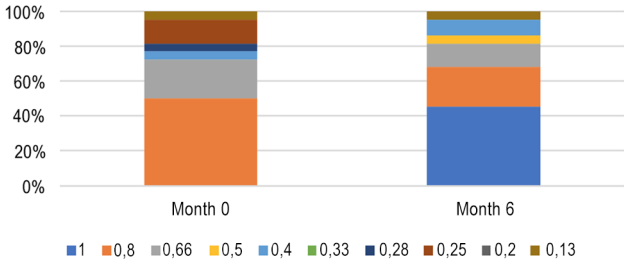

Figure 2. Comparison of visual acuity between baseline and six-month follow-up (N = 22).

Statistical analysis

Normality of the data was assessed using the Shapiro–Wilk test, which indicated that the data were not normally distributed. Therefore, the Wilcoxon signed-rank test was used to compare visual acuity before spectacle correction and at the one and six months follow-up visits. A P-value of less than 0.05 was considered statistically significant. All analyses were performed using Jamovi version 2.3.3.8.

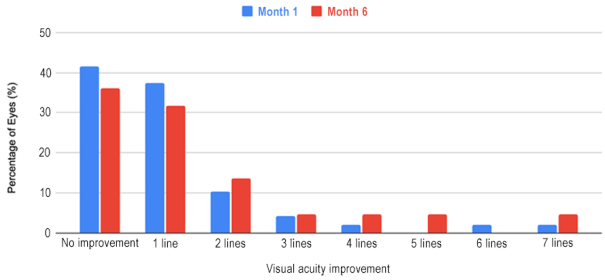

Figure 3. Visual acuity improvement at one and six months of follow-up.

Results

Among the total of 15,387 recorded cases, 594 subjects were identified as having refractive errors. Of the 594 subjects identified with refractive errors, 144 were diagnosed with refractive amblyopia, yielding a prevalence of 0.94% in the study population.

Table 1 summarizes the demographic and clinical characteristics of the study participants at baseline. A total of 29 patients who met the inclusion criteria were enrolled in the study. The mean age of the study participants was eight years, with an age range of 6 to 18 years. Based on sex distribution, the study population comprised 14 male subjects (48.3%) and 15 female subjects (51.7%). Regarding amblyopia laterality, 10 eyes (34%) were affected unilaterally, while 19 eyes (66%) demonstrated bilateral involvement.

Visual acuity improved after one month of spectacle correction, with a shift toward higher acuity levels compared to baseline (Figure 1). A greater proportion of eyes achieved visual acuity of 1.0 and 0.8 at the one-month follow-up. This improvement was statistically significant ($p = 0.045$). At six months, a further shift toward better visual acuity was observed compared to baseline (Figure 2), with more eyes reaching visual acuity of 1.0. The improvement at six months was also statistically significant ($p = 0.002$).

Visual acuity improved following spectacle correction at both follow-up periods (Figure 3). At one month, more than half of the eyes demonstrated some degree of improvement (58.4%), most commonly an increase of one Snellen line. At six months, a similar distribution of visual acuity changes was noted, with the majority of eyes showing stable or mild improvement (63.6%). Higher degrees of improvement were observed in a small proportion of eyes at both follow-up points. The reduced number of participants at the six months follow-up was due to attrition.

The comparison of spectacle correction effectiveness between the one and six months follow-up periods showed no substantial difference. Visual acuity improvement was observed in 16 eyes (72.7%) after one month of spectacle use, while 6 eyes (27.3%) showed no improvement. Similarly, at the six months follow-up, 14 eyes (63.6%) demonstrated improvement, whereas 8 eyes (36.4%) showed no improvement. Statistical analysis

revealed a p-value of 0.484, indicating that the difference in effectiveness between the one and six months therapy durations was not statistically significant ($p > 0.05$).

Discussion

The prevalence of refractive amblyopia in this study was 0.94%, with 144 cases identified among 15,387 pediatric patients seen at the ophthalmology clinic of Husada Utama Hospital, Surabaya, East Java, Indonesia, between December 2021 and December 2024. The prevalence of refractive amblyopia in this study was 0.94%, which is slightly lower than global estimates of overall amblyopia. For comparison, a systematic review reported a worldwide pooled prevalence of 1.36% (95% CI: 1.27–1.46%), while another meta-analysis of 60 studies (1.8 million subjects) found a pooled prevalence of 1.44% (95% CI: 1.17–1.78%). However, these figures encompass all types of amblyopia. The lower prevalence observed in our study may be attributed to the exclusive focus on refractive amblyopia. Notably, our finding aligns with the generally lower rates of amblyopia reported in Asian populations (1.09%) compared with those in Europe or North America.[19],[20]

The average age of children diagnosed with refractive amblyopia in this study was eight years, with an age range of 6 to 18 years. This is consistent with a previous study that reported a median age of eight years (range: 5–18 years), with the majority of cases (58.7%) occurring in children older than seven years.[21] A similar statement was supported by another study, which indicated that children aged seven to eight years are particularly vulnerable to amblyopia due to the ongoing visual development during this critical period.[7]

Another characteristic examined in this study was gender. In this cohort, a slightly higher prevalence of refractive amblyopia was observed in females (51.7%) than in males (48.3%). These findings are not consistent with previous research, which reported that males are more susceptible to refractive amblyopia. However, overall, the difference in prevalence between males and females was not statistically significant.[22]

Amblyopia may occur in one eye (unilateral) or both eyes (bilateral). The results of this study[13] showed that ten pediatric patients had unilateral amblyopia, while 19 had bilateral amblyopia. These findings are consistent with a previous study, which reported that among 40 subjects, five had unilateral amblyopia and 35 had bilateral amblyopia. Another study[23] conducted in Shanghai found that among 223 children with amblyopia, 129 had unilateral and 94 had bilateral amblyopia. Unilateral amblyopia may result from unequal retinal image formation, leading to blurred vision in one eye, whereas bilateral amblyopia occurs when both eyes exhibit reduced visual acuity.[6]

Visual acuity improved at both one and six months following spectacle correction in children with refractive amblyopia. The significant changes observed ($P = 0.045$ at one month; $P = 0.002$ at six months) indicate that early optical treatment alone can lead to meaningful gains in visual function. These findings are consistent with previous prospective studies demonstrating the efficacy of spectacle correction in improving vision in amblyopic children. One large multicenter study involving children aged three to less than ten years with bilateral refractive amblyopia reported an average improvement of 3.9 lines in binocular visual acuity after one year of spectacle wear, with 74% of children achieving 20/25 or better.[24] These prior findings support the present study's conclusion that optical correction alone, even in the absence of occlusion therapy, can result in clinically meaningful improvement in visual acuity during the early phase of amblyopia treatment.[25] Although these studies are dated, they remain foundational in amblyopia management and are frequently cited due to the scarcity of more recent large-scale prospective trials focusing exclusively on optical treatment.

The comparison of visual acuity outcomes in school-aged children with refractive amblyopia after one and six months of spectacle correction showed no statistically significant difference ($P = 0.484$). Visual improvement during the first month tended to be significant, likely due to the brain's high responsiveness to new visual stimuli provided by refractive correction. Over time, improvements tended to plateau, possibly due to cortical adaptation to the newly corrected vision. This phenomenon is supported by previous research, which reported that the greatest improvements in visual acuity with spectacle correction typically occur within the first 4–12 weeks, after which the progress tends to plateau.[17]

Amblyopia management is typically performed in a stepwise manner, with full-time spectacle correction as the initial treatment modality, particularly in newly diagnosed and treatment-naive patients. Occlusion therapy is generally reserved as a second-line intervention when adequate visual improvement is not achieved with optical correction alone. In the present study, all participants were diagnosed with refractive amblyopia for the first time and had no prior history of amblyopia treatment; therefore, spectacle correction was intentionally used as the sole therapeutic intervention during the observation period. This approach allowed the assessment of visual acuity improvement attributable exclusively to optical correction, without the confounding effects of occlusion therapy. The absence of occlusion therapy should thus be interpreted as a deliberate design choice rather than a limitation, reflecting real-world clinical practice in the initial management of refractive amblyopia.[26]

This study was conducted in a clinical setting that reflects real-world practice, enhancing its external

validity and relevance to primary eye care services. However, several limitations should be acknowledged. First, the number of participants differed between the one and six months evaluations due to the absence of 15 subjects who did not return for the latter follow-up. Second, spectacle correction compliance was not consistently monitored and may have varied among patients, potentially influencing visual outcomes. Lastly, as a retrospective study, the research was limited by incomplete or inconsistent documentation and the lack of control over variables during data collection.

Given the variability in spectacle compliance among participants and the notable loss to follow-up at six months, future interventions should emphasize parental education and engagement to improve treatment adherence and follow-up attendance, ultimately optimizing visual outcomes in children with refractive amblyopia.

Conclusions

The results of this study indicate that spectacle therapy alone led to a statistically significant improvement in visual acuity in children with refractive amblyopia at both one and six months of treatment. The majority of patients experienced improvements of ≥1 to ≥ 2 lines in visual acuity.

Acknowledgment

The authors declare that this work was conducted without external funding and without contributions from individuals outside the author group.

References

[1] Oktarima P, Caesarya S, Irfani I, Kuntorini M, Memed F, Ginting D. Hubungan usia dan jenis kelamin dengan jenis kelainan refraksi pada anak di Pusat Mata Nasional, Rumah Sakit Mata Cicendo. Oftalmol J Kes Mata Indones 2021;3:17–23.

[2] Zhou Y, Chen X, Huang X, Li L, Zhu Y, Cai Q, et al. Prevalence and association of uncorrected refractive error among Chinese adolescents: A cross-sectional study. BMC Public Health 2024;24:2904. https://doi.org/10.1186/s12889-024-20387-y.

[3] Levi DM. Amblyopia. In: Barton JJS, Leff A, editors. Handb. Clin. Neurol., vol. 178, Elsevier; 2021, p. 13–30. https://doi.org/10.1016/B978-0-12-821377-3.00002-7.

[4] Siu CR, Murphy KM. The development of human visual cortex and clinical implications. Eye Brain 2018;10:25–36. https://doi.org/10.2147/EB.S130893.

[5] Kapoor S. Update on diagnosis and management of amblyopia. Delhi J Ophthalmol 2019;29:95–97. https://doi.org/10.7869/djo.456.

[6] Wallace DK, Repka MX, Lee KA, Melia M, Christiansen SP, Morse CL, et al. Amblyopia preferred practice pattern®. Ophthalmology 2018;125:P105–142. https://doi.org/10.1016/j.ophtha.2017.10.008.

[7] Gopal SKS, Kelkar J, Kelkar A, Pandit A. Simplified updates on the pathophysiology and recent developments in the treatment of amblyopia: A review. Indian J Ophthalmol 2019;67:1392–1399. https://doi.org/10.4103/ijo.IJO_11_19.

[8] Blair K, Cibis G, Zeppieri M, Gulani AC. Amblyopia. StatPearls 2025. https://www.ncbi.nlm.nih.gov/books/NBK430890/ (accessed July 21, 2025).

[9] Mocanu V, Horhat R. Prevalence and risk factors of amblyopia among refractive errors in an Eastern European population. Medicina (Kaunas) 2018;54. https://doi.org/10.3390/medicina54010006.

[10] Ibrahimi D, Rodríguez-Reséndiz J, Mendiola-Santibañez JD. Differences in the visual performances of patients with strabismus, amblyopia, and healthy controls. Bioengineering (Basel) 2022;9. https://doi.org/10.3390/bioengineering9110626.

[11] McConaghy JR, McGuirk R. Amblyopia: Detection and treatment. Am Fam Physician 2019;100:745–750.

[12] Rajavi Z, Sabbaghi H, Baghini AS, Yaseri M, Moein H, Akbarian S, et al. Prevalence of amblyopia and refractive errors among primary school children. J Ophthalmic Vis Res 2015;10:408–416. https://doi.org/10.4103/2008-322X.176909.

[13] Deneska RS. Severity of amblyopia and its correlation with the amount of refractive error. Ophthalmol Indones 2015;41:84–88.

[14] Rahmadani NY, Himayani R, Sangging PRA. Article review: Deteksi dini ambliopia. Medula 2023;13:109–113.

[15] Syahmalya MA. Ambliopia: Prevalensi, faktor resiko, klasifikasi, dan terapi. J Medika Hutama 2022;3:2883–2892.

[16] Hsieh Y-C, Liao W-L, Tsai Y-Y, Lin H-J. Efficacy of vision therapy for unilateral refractive amblyopia in children aged 7-10 years. BMC Ophthalmol 2022;22:44. https://doi.org/10.1186/s12886-022-02246-9.

[17] Papageorgiou E, Asproudis I, Maconachie G, Tsironi EE, Gottlob I. The treatment of amblyopia: Current practice and emerging trends. Graefes Arch Clin Exp Ophthalmol 2019;257:1061–1078. https://doi.org/10.1007/s00417-019-04254-w.

[18] Martins Rosa A, Silva MF, Ferreira S, Murta J, Castelo-Branco M. Plasticity in the human visual cortex: An ophthalmology-based perspective. Biomed Res Int 2013;2013:568354. https://doi.org/10.1155/2013/568354.

[19] Hu B, Liu Z, Zhao J, Zeng L, Hao G, Shui D, et al. The global prevalence of amblyopia in children: A systematic review and meta-analysis. Front Pediatr 2022;10:819998. https://doi.org/10.3389/fped.2022.819998.

[20] Fu Z, Hong H, Su Z, Lou B, Pan C-W, Liu H. Global prevalence of amblyopia and disease burden projections through 2040: A systematic review and meta-analysis. Br J Ophthalmol 2020;104:1164–1170. https://doi.org/10.1136/bjophthalmol-2019-314759.

[21] Yulia DE, Barliana JD, Sitorus RS, Putri MR, Soeharto DA. Clinical characteristics of children with refrative amblyopia at Cipto Mangunkusumo National Referral Hospital. J Profesi Medika J Kedokt Kesehat 2024;18:21–29. https://doi.org/10.33533/jpm.v18i1.7582.

[22] Xiao O, Morgan IG, Ellwein LB, He M, Refractive error study in children study Group: Prevalence of amblyopia in school-aged children and variations by age, gender, and ethnicity in a multi-country refractive error study. Ophthalmology 2015;122:1924–1931. https://doi.org/10.1016/j.ophtha.2015.05.034.

[23] Wu J, Wang N. Prevalence and characteristics of amblyopia, strabismus, and refractive errors among patients aged 3-16 years in Shanghai, China: A hospital-based population study. BMC Ophthalmol 2024;24:239. https://doi.org/10.1186/s12886-024-03477-8.

[24] Wallace DK, Chandler DL, Beck RW, Arnold RW, Bacal DA, Birch EE, et al. Treatment of bilateral refractive amblyopia in children three to less than 10 years of age. Am J Ophthalmol 2007;144:487–496. https://doi.org/10.1016/j.ajo.2007.05.040.

[25] Cotter SA, Edwards AR, Wallace DK, Beck RW, Arnold RW, et al. Treatment of anisometropic amblyopia in children with refractive correction. Ophthalmology 2006;113:895–903. https://doi.org/10.1016/j.ophtha.2006.01.068.

[26] Gupta SB, Kashiv Y, Gaikwad H. Treatment of amblyopia: An update. MGM J Med Sci 2023;10:789–793. https://doi.org/10.4103/mgmj.mgmj_150_23.