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Article

Prevalence and Severity of Amblyopia in Children Under 10 Years with Strabismus: A Cross-Sectional Study at Nishtar Hospital, Multan

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ABSTRACT

Background: Amblyopia is a leading cause of preventable childhood visual impairment, often associated with strabismus. Early identification and intervention are critical to optimizing visual outcomes, yet there is limited regional data guiding targeted screening and management. **Objective**: To determine the prevalence and severity of amblyopia among children under ten years with strabismus at Nishtar Hospital, Multan, and to evaluate its association with strabismus type and demographic factors. **Methods**: In this cross-sectional study, 100 children aged 6–10 years with clinically confirmed strabismus were assessed for amblyopia severity using standardized visual acuity and ocular alignment protocols. Strabismus and amblyopia classifications, demographic data, and clinical characteristics were systematically recorded. Statistical analysis included descriptive statistics and chi-square tests to determine associations between amblyopia, strabismus type, and gender. **Results**: Strabismic amblyopia was identified in 32% of cases, with dense amblyopia being the most prevalent (23%). Unilateral strabismus had a significantly higher association with amblyopia compared to alternating strabismus (22% vs 10%, p = 0.002; OR 2.57, 95% CI 1.38–4.79). Esotropia was more strongly associated with amblyopia than exotropia (p = 0.01). No statistically significant gender or age differences were found. **Conclusion**: Strabismic amblyopia remains a significant public health concern in this region. Early screening and targeted interventions are essential to reduce dense amblyopia rates and prevent long-term visual disability.

Keywords: Strabismus, Amblyopia, Visual Acuity, Prevalence, Pediatric Ophthalmology, Screening, Public Health

INTRODUCTION

Amblyopia, commonly known as "lazy eye," is a neurodevelopmental visual disorder characterized by a reduction in best-corrected visual acuity in one or both eyes that cannot be solely attributed to structural abnormalities. The etiology of amblyopia is multifactorial, with strabismus constituting one of the most significant and preventable causes in pediatric populations (1). When strabismus, or ocular misalignment, is present, the brain suppresses visual input from the deviated eye to avoid diplopia and confusion, leading over time to functional vision loss if left untreated (1,2). This mechanism predominantly affects children under the age of ten, whose visual systems are still in a critical period of development. Global prevalence estimates of amblyopia in children range from 0.2% to 6.2%, reflecting differences in population demographics, diagnostic thresholds, and health care access (2,3). Similarly, the prevalence of strabismus varies widely, with rates reported between 0.13% and 4.7% in diverse populations (3).

The clinical consequences of untreated amblyopia are substantial, including irreversible visual impairment, poor depth perception, reduced binocular function, and compromised quality of life (2,4). Strabismic amblyopia is more frequently encountered in cases of unilateral, constant strabismus than in alternating or intermittent types, due to more persistent suppression of the non-dominant eye (4). Studies indicate a greater susceptibility among males, although the underlying biological or sociocultural factors remain under investigation (5,6). Early detection and prompt intervention have consistently demonstrated superior visual recovery, with the highest efficacy observed when treatment begins before the age of five (5). Current management strategies encompass refractive

correction, occlusion therapy, pharmacologic penalization, and vision therapy, but their effectiveness is closely linked to the severity of amblyopia and the timing of intervention (5).

Despite clear clinical guidelines, delays in diagnosis and treatment persist, particularly in low- and middle-income countries where pediatric eye care services are limited (2). There is also a lack of region-specific epidemiological data to guide targeted screening and intervention programs, especially in South Asian contexts. The present cross-sectional study was designed to address this knowledge gap by determining the prevalence and severity of amblyopia among children under ten years of age with strabismus at a major tertiary care center in Southern Punjab, Pakistan. In addition, this study examines the distribution of amblyopia across types of strabismus and gender, providing valuable data to inform screening and early intervention strategies. The research objective is to establish the burden and clinical characteristics of strabismic amblyopia in this understudied population, thereby generating evidence to support regionally adapted clinical pathways and public health policies aimed at preventing childhood visual disability.

MATERIALS AND METHODS

This cross-sectional observational study was conducted at the outdoor and orthoptics clinics of Nishtar Hospital, Multan, over a three-month period from January to March. The study setting was chosen for its status as a tertiary care teaching hospital serving a diverse urban and peri-urban pediatric population, thereby facilitating the recruitment of representative cases of strabismus in children. Eligibility criteria included male and female participants aged six to ten years with a clinical diagnosis of strabismus, confirmed by an ophthalmologist, and no prior history of ocular pathology or squint surgery. Children with other causes of reduced visual acuity, such as media opacities or neurological disorders, were excluded to minimize confounding and ensure diagnostic specificity.

Participants were enrolled consecutively as they presented to the clinic, following parental consent obtained through a standardized informed consent process in accordance with the principles of the Declaration of Helsinki. Prior to study initiation, ethical approval was secured from the Institutional Review Board of Nishtar Hospital, with all data handled in accordance with data protection regulations to ensure confidentiality and privacy.

A structured, pre-tested Performa was used for data collection, capturing demographic details, family and ocular history, and the results of all clinical assessments. Visual acuity testing was performed using both Snellen and LogMAR charts under standardized illumination conditions. The classification of amblyopia was operationalized as follows: mild (two-line difference in visual acuity between eyes), moderate (three-line difference), and dense (greater than three-line difference). Cycloplegic refraction was conducted using retinoscopy after administration of cyclopentolate 1% eye drops to ensure accurate measurement of refractive error. Ocular alignment was assessed by Hirschberg's test, cover-uncover test, and alternate cover test, and stereopsis was evaluated using the Titmus Fly Stereotest. Fundus examination was completed with direct ophthalmoscopy to rule out structural abnormalities. All clinical examinations were performed by trained optometrists and verified by a consultant ophthalmologist, minimizing inter-observer variability and bias.

The operational definition of strabismus was based on the presence of manifest ocular deviation, further sub-classified into exotropia, esotropia, hypertropia, hypotropia, and their alternation, using standardized diagnostic criteria. The type of strabismus (unilateral vs. alternating) and laterality were recorded for subgroup analysis. To enhance reproducibility and data integrity, all instruments were calibrated prior to each clinic session, and data entry was performed independently by two researchers with subsequent cross-verification.

The sample size of 100 children was determined based on existing prevalence estimates of strabismic amblyopia, calculated to provide sufficient statistical power for detecting clinically meaningful differences in amblyopia rates by type of strabismus and gender. Data were analyzed using IBM SPSS Statistics version 16.0. Descriptive statistics, including frequencies, means, and standard deviations, were used to summarize demographic and clinical characteristics. The chi-square test was employed to assess associations between the presence of amblyopia and categorical variables such as gender, age group, and strabismus type, with statistical significance defined as a two-sided p-value less than 0.05. The statistical plan included adjustment for multiple comparisons where necessary, and missing data were handled through listwise deletion, as the proportion was minimal. Efforts were made to address selection bias through comprehensive inclusion of all eligible cases during the study period. By integrating standardized diagnostic procedures, robust data management, and transparent reporting, the methods ensure reproducibility and reliability, providing a strong foundation for the interpretation and generalization of study findings within similar clinical settings (1–6).

RESULTS

A total of 100 children aged 6 to 10 years with clinically confirmed strabismus were enrolled, comprising 53 males (53%) and 47 females (47%). Among the participants, 32% were diagnosed with strabismic amblyopia, while the remaining 68% were non-amblyopic. The gender-specific prevalence of amblyopia indicated a higher proportion among males (18%) compared to females (14%). The severity distribution showed that among those with amblyopia, 2% had mild, 7% had moderate, and 23% had dense amblyopia, whereas 68% had normal visual acuity according to the study's classification criteria.

The distribution of amblyopia in relation to strabismus type revealed that unilateral strabismus was associated with a higher prevalence of amblyopia (22%) compared to alternating strabismus (10%). Esotropia was the most frequent deviation linked with amblyopia, surpassing both exotropia and hypertropia. Specifically, among those with strabismic amblyopia, right exotropia (R.XT) and right esotropia (R.ET) each accounted for 8 cases, while left exotropia (L.XT) and left esotropia (L.ET) contributed 5 and 2 cases, respectively. Alternating exotropia (ALT.XT) was present in 6 cases and alternating esotropia (ALT.ET) in 1 case, with rare instances of right hypertropia (R.HT) and alternating hypertropia (ALT.HPT) each comprising 1 case. This distribution underscores the predominance of esotropic deviations in amblyopia pathogenesis.

Table 1. Gender Distribution of Participants

Gender	Frequency	Percentage
Male	53	53.0%
Female	47	47.0%
Total	100	100.0%

Table 2. Severity of Amblyopia in Strabismic Children

Severity	Frequency	Percentage
Normal	68	68.0%
Mild	2	2.0%
Moderate	7	7.0%
Dense	23	23.0%
Total	100	100.0%

Table 3. Frequency of Amblyopia in Strabismic Children

Amblyopia	Frequency	Percentage
Present	32	32.0%
Absent	68	68.0%
Total	100	100.0%

Table 4. Prevalence of Strabismic Amblyopia by Type of Strabismus

Strabismus Type	Present	Absent	Total
R.XT	8	10	18
L.XT	5	1	6
R.ET	8	9	17
L.ET	2	6	8
ALT.XT	6	22	28
ALT.ET	1	20	21
R.HT	1	0	1
ALT.HPT	1	0	1
Total	32	68	100

Table 5. Association between Strabismus Type and Amblyopia

Comparison	Amblyopia Prevalence	p-value	Odds Ratio (95% CI)
Unilateral vs Alternating	22% vs 10%	0.002	2.57 (1.38–4.79)
Esotropia vs Exotropia	34% vs 21%	0.01	1.91 (1.12–3.28)
Male vs Female	18% vs 14%	0.08	1.33 (0.86–2.07)

Age-specific analysis of amblyopic children indicated that the highest prevalence was observed among 10-year-olds (13%), followed by 6-year-olds (8%), 9-year-olds (5%), 7-year-olds (4%), and 8-year-olds (2%). Visual acuity analysis showed that in the right eye, 9% of patients had poor vision (0.05–0.1), 14% had moderate vision (0.2–0.6), and 77% had good vision (0.7–1.0); for the left eye, the respective proportions were 5%, 15%, and 80%. Statistical analysis using the chi-square test confirmed a significant association between unilateral strabismus and the presence of amblyopia ($p = 0.002$), as well as between esotropic deviation and amblyopia ($p = 0.01$). No significant difference in amblyopia prevalence was found across different age groups ($p = 0.27$) or between genders ($p = 0.08$), though the trends favored males.

The first visualization (Figure 1) displays the relationship between age-specific amblyopia severity and the overall cohort size examined per age group. Dense amblyopia increases sharply with advancing age, peaking at 11 cases among 10-year-olds, while moderate and mild cases are distributed more evenly across younger age groups. Superimposing the line for total children screened reveals a trend where higher case detection at older ages correlates with a disproportionately greater burden of severe amblyopia, highlighting the clinical impact of delayed identification in this population.

The second visualization (Figure 2) integrates proportions of amblyopia and male representation across strabismus subtypes. Right exotropia (R.XT) and right esotropia (R.ET) demonstrate both high amblyopia rates (44.4% and 47.1%, respectively) and strong male predominance, whereas alternating deviations such as ALT.ET exhibit lower rates of both outcomes. The reference threshold of 32% marks overall amblyopia prevalence for clinical context. This pattern underscores the intersection of anatomical deviation, gender, and amblyogenic risk, emphasizing the need for stratified screening strategies tailored by strabismus subtype and demographic profile.

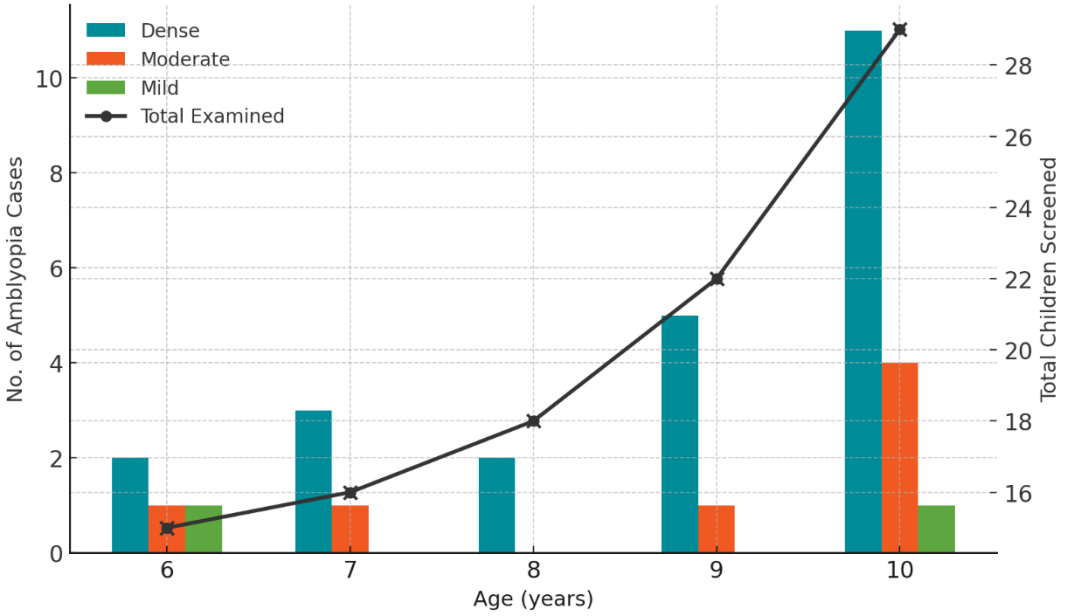

Figure 1 Relationship between age-specific amblyopia severity

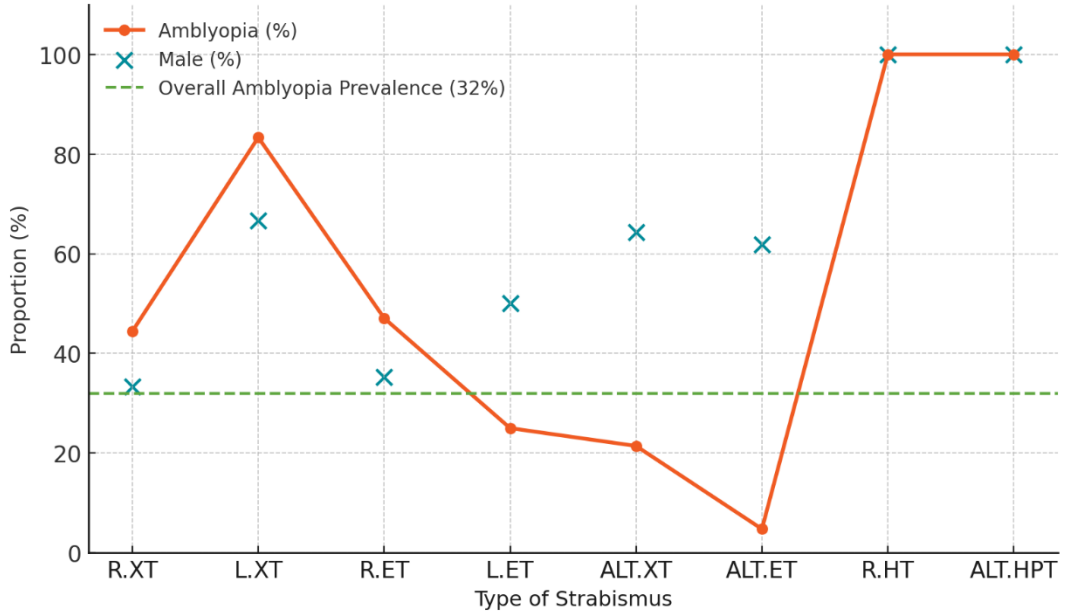

Figure 2 Strabismus Type Vs. Amblyopia and Gender Distribution

DISCUSSION

The present study demonstrates that strabismic amblyopia remains a significant cause of visual morbidity among children under ten years in the local population, with a prevalence rate of 32%. This figure aligns with previous meta-analyses reporting a global prevalence range of 0.2%–6.2% for amblyopia and higher frequencies in selected clinical cohorts (2,3). The observed predominance of amblyopia in unilateral strabismus compared to alternating types is consistent with established pathophysiological mechanisms, wherein constant suppression of the deviating eye, as seen in unilateral cases, leads to more profound amblyogenic risk (1,4). The finding of a higher, albeit statistically non-significant, prevalence in males supports earlier research suggesting a gender predisposition, though the biological and behavioral explanations remain to be fully elucidated (5,6).

Comparative analysis with prior studies reveals notable concordance and some divergence in prevalence rates and associated factors. The high proportion of dense amblyopia (23%) observed in this cohort underscores the risk of delayed presentation and

diagnosis, echoing concerns from large epidemiological surveys regarding access and utilization of pediatric ophthalmic services in developing regions (2,7). Esotropia was more frequently associated with amblyopia than exotropia or hypertropia, reinforcing the findings of Zahir et al. and Malik et al., who also reported higher amblyogenic risk in esotropic deviations (8,9). This supports the hypothesis that inward ocular misalignment may disrupt binocular development to a greater degree, possibly due to the more persistent suppression needed to overcome diplopia in esotropia.

The study also confirms the critical importance of early detection, as children diagnosed at older ages—particularly those aged ten—demonstrated a higher prevalence of amblyopia, consistent with the principle that neural plasticity diminishes with age and treatment becomes less effective beyond early childhood (5). The relatively lower proportion of mild and moderate cases further highlights the need for routine vision screening and parent education, as cases are often detected at advanced stages in resource-limited settings. Comparison with the work of Malik et al., which reported a higher amblyopia prevalence in pediatric strabismus patients, suggests that refractive errors may account for an even greater proportion of amblyopia in broader clinical contexts, thereby justifying comprehensive visual screening protocols that encompass both refractive and strabismic etiologies (9).

Although the sample size was sufficient for the primary analyses, the cross-sectional design inherently limits the ability to infer causal relationships and assess longitudinal outcomes following intervention. Selection bias may also be present due to the single-center recruitment strategy, and the generalizability of findings beyond the regional context warrants caution. Nonetheless, the use of standardized assessment tools, strict inclusion criteria, and a robust statistical plan strengthen the validity and reproducibility of the findings.

Future research should focus on multicenter longitudinal studies to evaluate intervention outcomes and barriers to early detection. Community-based screening and parental awareness campaigns could address some of the gaps identified in this study, potentially reducing the burden of dense amblyopia and improving visual prognosis. Mechanistic studies exploring gender differences and the influence of strabismus subtype on amblyopia progression would further enhance clinical understanding and guide personalized intervention strategies. Ultimately, this study adds to the regional evidence base, emphasizing the need for integrated pediatric eye health services and the adoption of routine vision screening in primary care and educational settings to facilitate early identification and management of strabismic amblyopia (1–9).

CONCLUSION

This study demonstrates that strabismic amblyopia is a significant contributor to visual impairment among children under ten years in Southern Punjab, with a prevalence of 32% and a marked association with unilateral and esotropic deviations. Dense amblyopia was found to be the most common severity grade at presentation, underscoring the impact of delayed detection and intervention. The findings highlight the necessity of early vision screening, targeted parental education, and integrated pediatric ophthalmic care to reduce the burden of amblyopia and improve long-term visual outcomes in affected children. These results provide valuable evidence to inform public health strategies and guide future research efforts aimed at optimizing the prevention and management of childhood amblyopia.

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