

Hyperopic Surprises in Children Undergoing Cycloplegic Autorefraction: A Cross-Sectional Study from an Eye Clinic in Jalalpur Jattan, Pakistan

PJO – Official Journal of
Ophthalmological Society of Pakistan



This work is licensed under a Creative Commons Attribution-Non-Commercial 4.0 International License.

Abdullah Murtaza¹, Kainat Malik², Sana Zahra³, Misbah Zainab⁴
^{1,2}Al-Shifa Laser Eye Center Jalalpur Jattan ^{3,4}LRBT PEC Thatha Ghulab
Singh

ABSTRACT

Purpose: To determine the frequency and magnitude of hyperopic surprises in children and to evaluate associated demographic and clinical correlates.

Study Design: Descriptive observational study.

Place and Duration of Study: Eye clinic in Jalalpur Jattan, Pakistan, from March 2025 to August 2025.

Methods: A total of 410 consecutive pediatric patients, 1–16 years of age were included. Non-cycloplegic autorefraction followed by cycloplegic autorefraction was performed after instillation of cyclopentolate hydrochloride 1%. A cycloplegic shift of $\geq +0.50$ diopters (D) was considered a clinically significant hyperopic surprise. Data were analyzed using paired t-test, one-way ANOVA, McNemar's test, and Pearson's correlation (SPSS v26; $p < 0.05$).

Results: Mean age was 8.6 ± 3.9 years, and 52.2% were male. A hyperopic surprise was identified in 61.7% (95% CI: 57.0–66.4%). Mean cycloplegic SE shift was $+0.73 \pm 0.67$ D. Hyperopia frequency rose from 18.6% to 53.2% post-cycloplegia ($p < 0.001$). Children aged 1–5 years showed the greatest mean shift (1.18 ± 0.85 D) versus 6–10 years (0.74 ± 0.63 D) and 11–16 years (0.52 ± 0.48 D; ANOVA, $p < 0.001$). Among children classified as myopic or emmetropic without cycloplegia, 65.3% were reclassified as hyperopic. No significant sex-based difference was found ($p = 0.617$). A moderate negative correlation existed between hyperopic surprise magnitude and uncorrected visual acuity ($r = -0.47$, $p < 0.001$).

Conclusion: Non-cycloplegic autorefraction substantially underestimates hyperopia in children and produces clinically significant refractive miscalculations. Cycloplegic refraction is indispensable for accurate pediatric refractive assessment, particularly in preschool children.

Keywords: Hyperopia, Refraction, Ocular, Amblyopia, Esotropia, Pakistan.

How to Cite this Article: Murtaza A, Malik K, Zahra S, Zainab M. Hyperopic Surprises in Children Undergoing Cycloplegic Auto refraction: A Cross-Sectional Study from an Eye Clinic in Jalalpur Jattan, Pakistan. 2026;42(4):1-6. **Doi:10.36351/pjo.v42i4.2469**

Correspondence: Abdullah Murtaza
Al-Shifa Laser Eye Center, Jalalpur Jattan
Email: abdullahmurtaza146@gmail.com

Received: May 17, 2026
Revised: August 12, 2026
Accepted: August 24, 2026

INTRODUCTION

Refractive error is among the most prevalent and

reversible causes of visual impairment in children.¹ Among the principal refractive conditions, hyperopia presents a diagnostic challenge unique to the pediatric age group due to the robust accommodative reserve of the juvenile crystalline lens. A hyperopic child may maintain clear vision at all distances while the underlying refractive error remains entirely occult to non-cycloplegic autorefraction.² The discrepancy between spherical equivalent obtained under cycloplegia and that obtained without it when the cycloplegic value is more hyperopic by ≥ 0.50 D is

termed a hyperopic surprise, representing latent hyperopia. This 0.50 D threshold is consistently adopted in the literature as the minimum clinically meaningful cycloplegic shift in pediatric populations.³

The consequences of undetected hyperopia are well established. Moderate-to-high hyperopia is a leading risk factor for accommodative esotropia and anisometropic amblyopia.⁴ A prospective study of 1,044 children found that hyperopia was the dominant refractive feature among esotropic patients (36.54%), with amblyopia present in 26.92% of strabismic cases.⁵ Optical correction initiated at an early stage yields substantially better outcomes than correction initiated later in life.

Published Pakistani refractive data are predominantly from large urban centres.⁶ Data addressing the burden of hyperopic surprises in children attending clinics in semi-urban settings is scarce. This study aimed to determine the prevalence and magnitude of hyperopic surprises in children aged 1–16 years attending an eye clinic in Jalalpur Jattan, Gujrat District, Punjab, Pakistan.

METHODS

A prospective cross-sectional study was conducted at an eye clinic in Al-Shifa Laser Eye Clinic, over six consecutive months following institutional board approval. The study adhered to the Declaration of Helsinki. Consecutive pediatric patient's aged 1–16 years, presenting for refractive evaluation were enrolled after written informed consent from parents or legal guardians. Exclusion criteria comprised hypersensitivity to cyclopentolate, prior intraocular surgery, media opacity affecting refraction, systemic anticholinergic medication use, and prior cycloplegic refraction within two weeks. Sample size was calculated using $n = Z^2p(1-p)/e^2$, based on a published prevalence of 60.2% for clinically significant cycloplegic shift, yielding a minimum of 369 participants ($Z = 1.96$; $e = 0.05$), adjusted to 410 after accounting for 10% exclusions.⁷

Uncorrected visual acuity (UCVA) was measured using a Snellen chart at six meters (≥ 5 years), HOTV chart (3–4 years), or Cardiff Acuity Cards (< 3 years), recorded in LogMAR. Non-cycloplegic autorefractometer was performed using a calibrated table-mounted autorefractometer, with three readings averaged per eye. Cyclopentolate hydrochloride 1% was instilled as two drops per eye at a five-minute interval (0.5% for

children below twelve months). Cycloplegic autorefractometer was performed thirty minutes after these drops, confirmed adequate by absence of direct pupillary light reflex in a bright room. Three readings were averaged per eye. SE was calculated as sphere + (cylinder $\div$ 2). A hyperopic surprise was defined as a cycloplegic SE $\geq +0.50$ D more hyperopic than the non-cycloplegic SE.

Data were analysed using IBM SPSS Statistics v26.0. Continuous variables were presented as means with standard deviations and categorical variables as frequencies and percentages. Paired samples t-test compared mean SE. McNemar's test assessed refractive reclassification. One-way ANOVA with post-hoc Tukey correction evaluated age-group differences. Independent t-test and Chi-square test examined sex-based differences. Pearson's correlation assessed the relationship between hyperopic shift magnitude and UCVA. Significance was set at $p < 0.05$ (two-tailed).

RESULTS

Of 426 screened children, 16 were excluded (12 inadequate fixation; 4 pre-existing ocular pathology), leaving 410 in the final analysis. The Mean age was 8.6 ± 3.9 years (range 1–16 years) and 214 participants (52.2%) were male. The most frequent presenting complaint was blurred vision (48.3%), followed by routine examination (22.9%), esotropia (15.1%), and other symptoms (13.7%). Demographic characteristics are presented in Table 1.

Table 1: Demographic characteristics of study participants ($n=410$).

Characteristic	Category	n	%
Sex	Male	214	52.2
	Female	196	47.8
Age Group	1–5 years	118	28.8
	6–10 years	162	39.5
	11–16 years	130	31.7
Mean Age (years)	8.6 ± 3.9 (range: 1–16)	—	—
Prior Spectacles	Yes	87	21.2
	No	323	78.8
Presenting Complaint	Blurred vision	198	48.3
	Esotropia	62	15.1
	Routine examination	94	22.9
	Other	56	13.7
Total	—	410	100.0

Cycloplegia produced substantial refractive

Table2: Refractive classification before and after cycloplegia (right eye; n = 410).

Refractive Category	Non-Cycloplegic (%)	Cycloplegic n(%)	Net Change (n)
High myopia(<-6.00D)	18 (4.4)	14 (3.4)	-4
Moderate myopia(-3.01to-6.00D)	44 (10.7)	32 (7.8)	-12
Low myopia(-0.50to-3.00D)	120 (29.3)	78 (19.0)	-42
Emmetropia(-0.50to<+0.50D)	152 (37.1)	68 (16.6)	-84
Low hyperopia(+0.50to<+2.00 D)	52 (12.7)	118 (28.8)	+66
Moderate hyperopia(+2.00to<+5.00D)	18 (4.4)	82 (20.0)	+64
High hyperopia(≥+5.00D)	6 (1.5)	18 (4.4)	+12
Total	410 (100.0)	410 (100.0)	—

McNemar's test: $p < 0.001$. Hyperopia: 18.6% (non-cycloplegic) → 53.2% (cycloplegic).

Table3: Prevalence and magnitude of hyperopic surprise by age group.

Age Group	n	Hyperopic Surprise (%)	Mean SE Shift ± SD (D)	p-value
1-5 years	118	89 (75.4%)	1.18 ± 0.85	<0.001
6-10 years	162	102 (63.0%)	0.74 ± 0.63	<0.001
11-16 years	130	70 (53.8%)	0.52 ± 0.48	<0.001
Total	410	261 (63.7%)	0.73 ± 0.67	<0.001

One-way ANOVA: $F(2,407) = 38.4$, $p < 0.001$. All pairwise comparisons are significant on post-hoc Tukey correction.

reclassification. Prior to cycloplegia, 44.4% (n=182) were classified as myopic, 37.1% (n = 152) as emmetropic, and 18.6% (n = 76) as hyperopic. Following cycloplegia, the proportion classified as myopic fell to 30.2% (n=124) and emmetropia to 16.6% (n = 68), while hyperopia rose to 53.2% (n = 218), a 34.6 percentage-point increase (McNemar's test, $p < 0.001$). Full reclassification data are shown in Table 2.

A clinically significant hyperopic surprise was identified in 253 out of 410 children in the right eye (61.7%; 95% CI: 57.0–66.4%) and 248 in the left eye (60.5%; 95% CI: 55.7–65.1%); at least one eye was affected in 261 children (63.7%). The mean cycloplegic SE shift was $+0.74 \pm 0.68$ D (right eye) and $+0.71 \pm 0.66$ D (left eye). Paired t-test confirmed a statistically significant difference between non-cycloplegic and cycloplegic SE (right: mean difference -0.73 ± 0.68 D, $t = -21.8$, $df = 409$, $p < 0.001$; left: -0.71 ± 0.66 D, $t = -21.0$, $p < 0.001$).

Age-stratified analysis demonstrated a statistically significant inverse relationship between age and the magnitude of hyperopic surprise (ANOVA: $F(2, 407) = 38.4$, $p < 0.001$; Table 3). Tukey correction confirmed significance for all pairwise comparisons: 1–5 vs 6–10 years ($p < 0.001$), 1–5 vs 11–16 years ($p < 0.001$), and 6–10 vs 11–16 years ($p = 0.008$).

Among 334 children classified as myopic (n = 182) or emmetropic (n = 152) on non-cycloplegic autorefractometry, 218 (65.3%) were reclassified as

hyperopic following cycloplegia ($p < 0.001$). The reclassification rate was highest among children initially classified as emmetropic (122/152; 80.3%). No statistically significant sex-based difference was identified in the prevalence (62.6% male vs 64.8% female; $p = 0.617$) or mean magnitude (0.71 ± 0.65 D vs 0.75 ± 0.69 D; $p = 0.482$) of hyperopic surprise. A moderate negative correlation was found between the magnitude of hyperopic surprise and presenting UCVA in LogMAR ($r = -0.47$; 95% CI: -0.54 to -0.40 ; $p < 0.001$). The severity distribution of hyperopic surprise and a summary of all primary and secondary outcomes are presented in Tables 4 and 5, respectively.

Table4: Severity distribution of hyperopic surprise among affected children.

Severity Category	SE Shift Range	Right Eye n (%)	Left Eye n (%)
Mild	+0.50 to +1.00 D	138 (54.5%)	136 (54.8%)
Moderate	+1.01 to +2.00 D	88 (34.8%)	84 (33.9%)
High	>+2.00 D	27 (10.7%)	28 (11.3%)
Total	—	253 (100.0%)	248 (100.0%)

DISCUSSION

This study demonstrates that non-cycloplegic autorefractometry substantially underestimates hyperopia in children attending an eye clinic and produces refractive misclassification in the majority of cases. A hyperopic surprise was identified in 61.7% of children.

Table5: Summary of primary and secondary statistical outcomes.

Outcome	Statistical Test	Result	p-value
Prevalence of hyperopic surprise	Descriptive statistics	61.7%(95%CI:57.0–66.4%)	—
Mean SE shift (righteye)	Paired t-test	-0.73±0.68D;t= -21.8	<0.001
Age-group comparison	One-way ANOVA	F(2,407)=38.4	<0.001
Refractive misclassification	McNemar's test	65.3% reclassified	<0.001
Sex-based difference	t-test; Chi-square	Not significant	0.617
Hyperopic surprise vs UCVA	Pearson's r	r = -0.47	<0.001

SE= Spherical equivalent; UCVA= Uncorrected visual acuity.

Closely concordant with the 60.2% reported earlier lending external validity to the present findings.⁷ In that study, only 26% of true hyperopes were correctly categorized without cycloplegia.

The 34.6 percentage-point increase in hyperopia prevalence following cycloplegia is consistent with data from the Eastern Mediterranean Region, where a systematic review of 51,987 children reported hyperopia prevalence of 7.35% with cycloplegic versus 3.93% without cycloplegic refraction.⁸ The larger absolute increase in our clinic-based sample reflects the enriched prevalence of refractive error expected in symptomatic help-seeking populations compared to community-based samples.

The age-stratified findings, mean cycloplegic shifts of 1.18 D, 0.74 D, and 0.52 D in the 1–5, 6–10, and 11–16-year groups, respectively are consistent with the known inverse relationship between accommodative amplitude and age.¹ Preschool children are not only most susceptible to the diagnostic gap but are developmentally most vulnerable, uncorrected hyperopia during the critical period of visual cortical plasticity is a modifiable risk factor for amblyopia whose treatment window narrows progressively after age five.⁴

The misclassification rate of 65.3%, with 80.3% of emmetropic-appearing children found to be hyperopic on cycloplegia, represents a clinically unacceptable rate of diagnostic error. A single missed diagnosis in a resource-limited setting with inconsistent follow-up risks irreversible visual loss during the sensitive period of visual development.⁹

The absence of a sex-based difference is consistent with published data, and the moderate negative UCVA correlation ($r = -0.47$) confirms that visual acuity testing alone is an imperfect screening proxy for latent hyperopia.⁷ Children with substantial cycloplegic shifts may present with acuity insufficient to trigger clinical concern on non-cycloplegic examination.

Another study reported that prevalence of emmetropia decreased from 37.5% before cycloplegia to 19.8% after cycloplegia.¹⁰ Similarly, in a Chinese study, noncycloplegic autorefraction was found to be highly inaccurate in school-age children and, thus, not suitable for studies of refractive error or for prescription of glasses in this population.¹¹ In another study, female gender (coefficients = 0.048), older age (coefficients = -0.247), higher education (coefficients = -0.043), and cycloplegic SE (coefficients = -0.472) significantly correlated with lower inter-method differences.¹²

We used cyclopentolate for cycloplegia, but a systematic review showed that tropicamide may be considered as a viable substitute for cyclopentolate due to its rapid onset of action.¹³ However, the authors suggested that the results should be used cautiously in infants and in patients with high hyperopia or strabismus when using tropicamide as the sole cycloplegic agent especially in situations that where the findings are variable.

Regarding effect on astigmatism, it has been reported that the differences in astigmatism power and axis between non-cycloplegic and cycloplegic conditions were not statistically significant, suggesting that cycloplegia primarily affects spherical refractive components.¹⁴

Limitations of this study include its single-site, clinic-based design introducing selection bias, use of cycloplegic autorefraction rather than subjective refraction as the reference standard, restriction to cyclopentolate 1% rather than atropine 1%, which may marginally underestimate latent hyperopia in very young children, and absence of longitudinal follow-up data on visual outcomes.

CONCLUSION

Non-cycloplegic autorefraction fails to identify the majority of children with clinically significant latent

hyperopia and results in refractive misclassification in over 65% of cases. The burden of undetected hyperopia is greatest in the preschool age group, where both accommodative amplitude and developmental vulnerability are highest. Cyclopentolate hydrochloride 1% cycloplegic refraction is indispensable for accurate pediatric refractive assessment and should be routinely adopted as the standard of care in eye clinics serving semi-urban populations in Pakistan.

ACKNOWLEDGEMENTS

The authors acknowledge the staff of the eye clinic, Jalalpur Jattan, for their cooperation during data collection, and the families of all participating children for their willingness to contribute to this research. No specific acknowledgement is due to any individual for a named figure or table.

Funding: This study was not funded by any organization.

Patient's Consent: Researchers followed the guidelines set forth in the Declaration of Helsinki.

Conflict of Interest: Authors declared no conflict of interest.

Ethical Approval: The study was approved by the Institutional review board/Ethical review board (ACALEC/ERC/2026/034)

REFERENCES

1. **Cao H, Cao X, Cao Z, Zhang L, Han Y, Guo C.** The prevalence and causes of pediatric uncorrected refractive error: Pooled data from population studies for Global Burden of Disease (GBD) sub-regions. *PLoS One*. 2022;**17**(7):e0268800. Doi: 10.1371/journal.pone.0268800.
2. **Ho M, Morjaria P.** Cycloplegic refraction in children. *Community Eye Health*. 2024;**37**(122):14-15. PMID: 38827966; PMCID: PMC11141127.
3. **Sanfilippo PG, Chu BS, Bigault O, Kearns LS, Boon MY, Young TL, Hammond CJ, Hewitt AW, Mackey DA.** What is the appropriate age cut-off for cycloplegia in refraction? *Acta Ophthalmol*. 2014;**92**(6):e458-462. Doi: 10.1111/aos.12388.
4. **Borchert MS, Varma R, Cotter SA, Tarczy-Hornoch K, McKean-Cowdin R, Lin JH, et al.** Multi-Ethnic Pediatric Eye Disease Study and the Baltimore Pediatric Eye Disease Study Groups. Risk factors for hyperopia and myopia in preschool children the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. *Ophthalmology*. 2011;**118**(10):1966-1973. Doi: 10.1016/j.ophtha.2011.06.030.
5. **Kumar V, Soni M, Rajagopal V, Behera A, Gandhi A, Shamim MA, et al.** The Prevalence of Refractive Errors in Indian School Children: A Systematic Review and Meta-Analysis. *Ophthalmic Epidemiol*. 2026;**33**(2):162-171. Doi: 10.1080/09286586.2025.2450346.
6. **Alam H, Siddiqui MI, Jafri SI, Khan AS, Ahmed SI, Jafar M.** Prevalence of refractive error in school children of Karachi. *J Pak Med Assoc*. 2008;**58**(6):322-325. PMID: 18988392.
7. **Sankaridurg P, He X, Naduvilath T, Lv M, Ho A, Smith E 3rd, et al.** Comparison of noncycloplegic and cycloplegic autorefraction in categorizing refractive error data in children. *Acta Ophthalmol*. 2017;**95**(7):e633-e640. Doi: 10.1111/aos.13569.
8. **Al-Rasheed SH, Challa NK.** Prevalence of hyperopia in school-aged children in eastern Mediterranean region: A systematic review and meta-analysis. *Saudi J Ophthalmol*. 2023;**38**(3):243-251. Doi: 10.4103/sjopt.sjopt_47_23.
9. **Mocanu V, Horhat R.** Prevalence and Risk Factors of Amblyopia among Refractive Errors in an Eastern European Population. *Medicina (Kaunas)*. 2018;**54**(1):6. Doi: 10.3390/medicina54010006.
10. **Tharwat S.** Effect of cycloplegia on the refractive status of children. *Afr Vis Eye Health*. 2024;**83**(1):a916. Doi: 10.4102/aveh.v83i1.916.
11. **Zhao J, Mao J, Luo R, Li F, Pokharel GP, Ellwein LB.** Accuracy of noncycloplegic autorefraction in school-age children in China. *Optom Vis Sci*. 2004;**81**(1):49-55. Doi: 10.1097/00006324-200401000-00010.
12. **Hashemi H, Khabazkhoob M, Asharlous A, Soroush S, Yekta A, Dadbin N, et al.** Cycloplegic autorefraction versus subjective refraction: the Tehran Eye Study. *Br J Ophthalmol*. 2016;**100**(8):1122-1127. Doi: 10.1136/bjophthalmol-2015-307871.
13. **Yazdani N, Sadeghi R, Momeni-Moghaddam H, Zarifmahmoudi L, Ehsaei A.** Comparison of cyclopentolate versus tropicamide cycloplegia: A systematic review and meta-analysis. *J Optom*. 2018;**11**(3):135-143. Doi: 10.1016/j.optom.2017.09.001.
14. **Panke K, Jorova M.** Objective Refraction Status before and after Cycloplegia: From Childhood to Young Adulthood. *Vision (Basel)*. 2024;**8**(3):51. Doi: 10.3390/vision8030051.

Authors Designation and Contribution

Abdullah Murtaza; Optometrist: *Concepts, Design, Literature Search, Data Acquisition, Data Analysis, Statistical Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.*

Kainat Malik; Optometrist: *Concepts, Design, Data Acquisition, Data Analysis, Statistical Analysis, Manuscript Preparation, Manuscript*

Review.

Sana Zahra; Optometrist: *Concepts, Literature Search, Data Acquisition, Data Analysis, Manuscript Preparation, Manuscript Editing, Manuscript Review.*

Misbah Zainab; Optometrist: *Concepts, Data Acquisition, Data Analysis, Statistical Analysis, Manuscript Editing, Manuscript Review.*

