



**A STUDY OF REFRACTIVE ERRORS, STRABISMUS AND AMBLYOPIA IN  
PAEDIATRIC PATIENTS OF SOUTH INDIA**

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**ABSTRACT**

Refractive errors are a major contributor to burden of vision problems. This study was done to determine the magnitude & distribution of refractive errors, strabismus and amblyopia in paediatric patients at a tertiary care hospital in Southern India. **Objectives:**

1. Estimate the number, magnitude & pattern of refractive errors.
2. Analyze associations between refractive error and different types of strabismus & amblyopia.

**Materials and Methods:** This was a cross-sectional, observational study. This study was performed at a tertiary care hospital in Tamil Nadu from Feb 2018 to Feb 2019. A total of 512 children, aged 5–15 years, whose parents consented for this study were chosen. All the children underwent complete ophthalmic examination with cycloplegic refraction according to standard hospital protocol. Patients were grouped into three categories – myopia, hypermetropia & mixed astigmatism. Snellen's chart was used & acuities were converted into LogMAR equivalents. Compound hypermetropes were classified into myopia or hypermetropia based on their spherical equivalents. The collected data was analysed by excel & SPSS version 25.0. **Results:** Refractive errors were found in 64.4% (n=330) of the cases, the commonest type of refractive error being myopia which comprised of 60% (n=198) of patients. Strabismus and amblyopia were seen in 37.87% (n=125) and 19.09% (n=63), respectively. The maximum magnitude of error was -4.50D of myopia, +4.00D hypermetropia, -2.50D of astigmatism. Hypermetropes within the range of 1.50 to 2.50D of refractive error had the maximum incidence of strabismus & amblyopia. **Conclusions:** Myopia was the most common refractive error, this is in coherence with other studies which were done under similar settings to ours. The burden of refractive errors and sequelae is heavy, hence it is important to promote awareness about early detection of refractive errors and have frequent & focused screening programmes in schools.

**KEYWORDS:** Amblyopia, children, refractive errors, strabismus.

**INTRODUCTION**

Visual impairment affects a large population world-wide. Around 285 million people worldwide are visually impaired. Of this, 19 million comprise of children below the age of 14 years. Around 43% of this population is visually impaired due to refractive errors, which is the prime cause of visual impairment in children.<sup>[1]</sup> Refractive error refers to a condition of the eye in which the eye fails to focus the image on the retina resulting in blurred vision, when accommodation is at rest.<sup>[2]</sup>

Visual impairment due to refractive errors can have long-term consequences in children. Of the number of children having refractive error, 12.8 million are between 5 to 15 years old, a global prevalence of 0.96%.<sup>[3]</sup> Literature indicates that refractive errors are the leading cause of visual impairment in school children in South India. Studies in India, have reported the prevalence of refractive errors in school children as 13.6–30.57%.<sup>[4,5]</sup> There have not been many studies done in Southern India with such a population range & sample size. A number of factors are responsible for uncorrected refractive errors, including the lack of awareness of the problem,

inability to recognize the problem by their school teachers or parents, non-availability or non-affordability of eye care services and also cultural factors to compliance.<sup>[3]</sup>

Uncorrected refractive error can cause amblyopia and/ or strabismus. The risk of developing amblyopia increases as the hypermetropic refractive error or anisometropia increase. There is no set level of refractive error above which amblyopia is certain or below which amblyopia is impossible.

### OBJECTIVES

1. Estimate the number, magnitude & pattern of refractive errors.
2. Analyze associations between refractive error and different types of strabismus & amblyopia.

This was to estimate the burden of pediatric refractive error related eye problems and gather information for planning of eye screening & camp services in our region.

### MATERIALS AND METHODS

This hospital based cross-sectional study was conducted at a tertiary care hospital. The center is located in Perambalur district & receives patients from Perambalur city, Ariyalur and its surrounding villages primarily. The study was carried out from Feb 2018 to Feb 2019. During this period, all children whose parents/ guardians consented and were between the ages of 5 to 15 years visiting the OPD were included. Informed consent for conduct of the study was taken from the children's parents/ guardians.

#### Inclusion & exclusion criteria

##### Inclusion

- All patients between 5 to 15 years of age presenting with decreased visual acuity/ strabismus.
- Patients with amblyopia (having a decrease in visual acuity not improving with pinhole/ refraction with no identifiable organic pathology on examination).

##### Exclusion

- Clinical examination findings suggestive of pathology of the eye other than refractive error/ amblyopia/ strabismus causing a decrease in the visual acuity.
- Keratoconus by refraction & improvement in visual acuity with pinhole, keratometry & corneal topography.

### METHODOLOGY

All patients underwent a thorough ophthalmic examination with a detailed history, refraction, uncorrected visual acuity (VA), and best corrected visual acuity (BCVA) using snellen's chart, with visual acuity converted into LogMAR equivalent, cycloplegic refraction was conducted using 1% cyclopentolate. The presence or absence of amblyopia and strabismus was noted using alternate cover test.

Normal VA for the purpose of this study was defined as an uncorrected VA equal to or better than 0.3 logMAR equivalent in the better eye. Amblyopia was defined as initial BCVA of 0.20 logMAR equivalent or worse, and at least two line logMAR differences between the amblyopic and fellow eye, without ocular pathology in either eye. Strabismus was defined as an intermittent or constant horizontal deviation of 10 or more prism diopters (DS), a vertical deviation of 3 or more prism DS, or other eye movement disorders.

The patients were grouped as follows: Myopia with a refractive error of more than -0.50 DS and hypermetropia with a refractive error of more than +0.50 DS. Hypermetropia and myopia were further subdivided into three subgroups based on the spherocylinder power of the refraction, namely: Mild if  $\leq 1.00$  DS, moderate from 1.25 to 2.50 DS, and high if  $> 2.50$  DS.

Refractive error was classified as simple hypermetropia or myopia if not associated with astigmatism. Compound astigmatism was divided into two groups: Compound myopic astigmatism or compound hyperopic astigmatism and each was classified as follows: Mild if compound astigmatism  $< 1.00$  DS, moderate if compound astigmatism was between 1.25 and 2.50 DS, high if compound astigmatism was more than 2.50 DS.

Only mixed astigmatism was considered as a separate entity & compound astigmatism was reduced to the spherical equivalent in our study.

### RESULTS

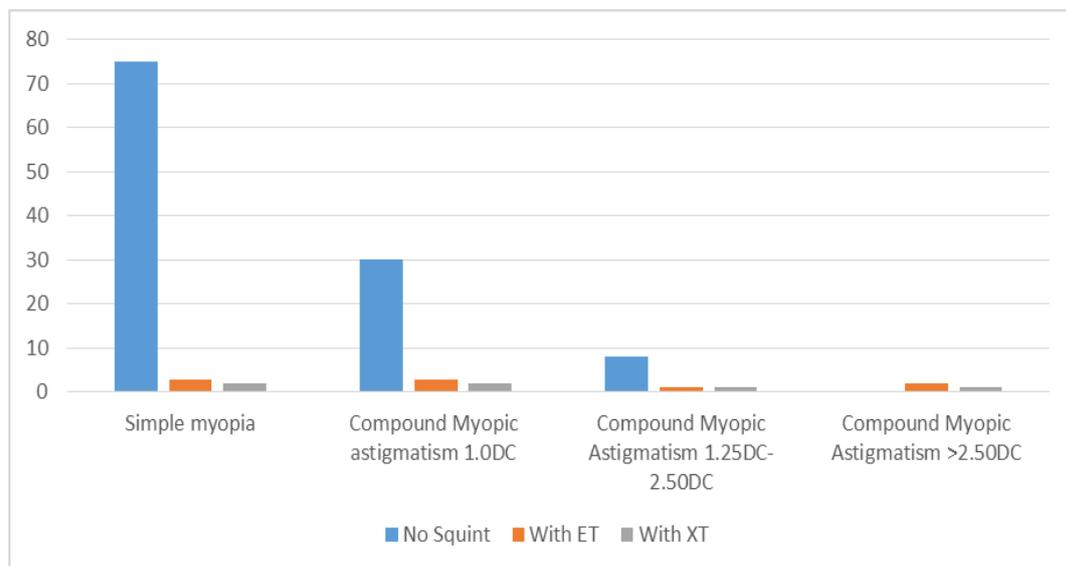
Amongst the patients presenting to our OPD, a total of 512 children whose parents consented for this study were included. The mean age of the children was 7.6 years ( $\pm 3.64$  years) with an age range of 5-15 years. Of the 512 children, a total of 330 (64.4%) were found to have refractive errors of which 51% were males. Of the total 330 patients with refractive errors, 60% (198) were myopes, 44% (145) were hypermetropes, and 16% (52.8) had astigmatism.

**Table 1:** Shows the distribution of refractive error subtypes. Strabismus was seen in 37.87% (125) of the children.

	Number of patients (%)	Sub-groups of RE (DS)	Number of patients (%)
Hypermetropia	112(34)	<1.00	20(6.12)
		1.25 – 2.50	83(24.06)
		>2.50	9(4.75)
Myopia	198(60)	<1.00	92(27.87)
		1.25 - 2.50	58(17.57)
		>2.50	48(14.54)
Mixed astigmatism	20(6)		

**Table 2:** Shows the distribution of strabismus in the myopic group.

	Simple Myopia(%)	Compound myopic astigmatism <1.00D(%)	Compound myopic astigmatism 1.00-2.50 D(%)	Compound myopic astigmatism <2.50D(%)
No Squint	82(60)	25(20)	8(6.4)	0
ET	3(2.4)	3(2.4)	1(0.8)	2(1.6)
XT	2(1.6)	2(1.6)	1(0.8)	1(0.8)

**Figure 1:** Distribution of strabismus types among myopic children in relation to subtypes of refractive error.

Exotropia was the predominant type of strabismus in children with myopia, with no obvious relation between the extent of compound myopic astigmatism and the frequency of strabismus. Esotropia was substantially

more frequent in children with mild-moderate compound hyperopic astigmatism than in children with myopia ( $P = 0.0001$ ).

**Table 3:** Shows the distribution of strabismus in the hypermetropic group.

	Simple Hypermetropia (%)	Compound hypermetropic astigmatism <1.00D(%)	Compound hypermetropic astigmatism 1.00-2.50 D(%)	Compound hypermetropic astigmatism <2.50D(%)
No Squint	75(61.98)	28(23.14)	0	0
ET	2(1.65)	0	5(4.13)	0
XT	3(2.47)	2(1.65)	4(3.3)	0

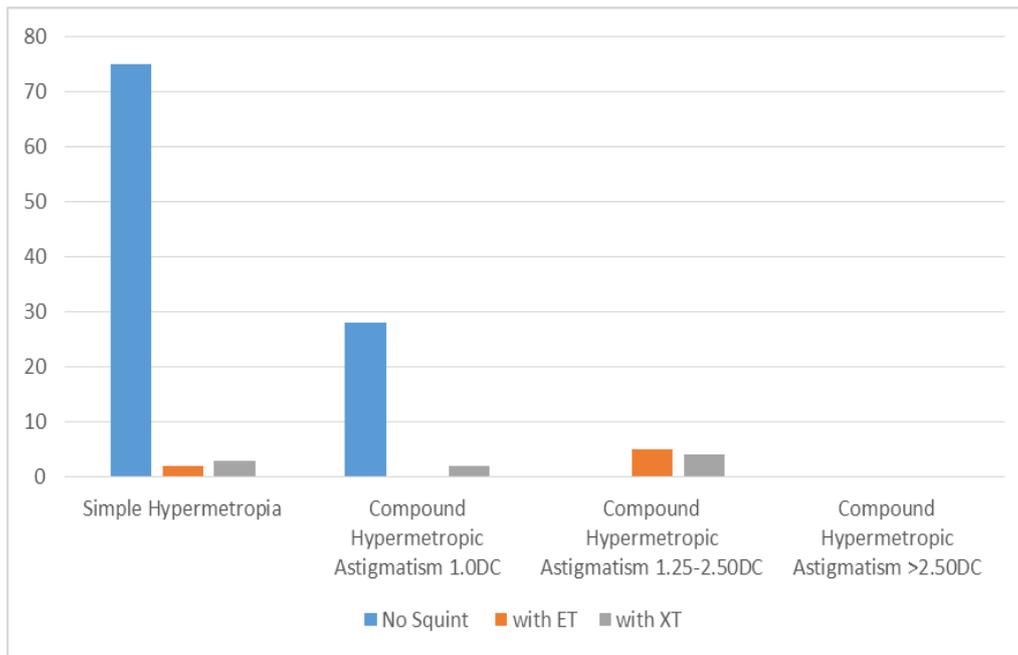


Figure 2: Shows the distribution of strabismus in hypermetropic subtypes.

There was no relation between the extent of compound hyperopic astigmatism and the frequency of strabismus. The refractive errors were equally distributed between strabismic and non-strabismus children.

Figure 3 shows the distribution of refractive errors among amblyopic children in relation to the presence and type of associated strabismus. There was no statistically

significant difference in the distribution of amblyopia among the children who had esotropia and children without strabismus. The majority of amblyopic children had mild to moderate compound hypermetropic astigmatism, while 19.2% had high astigmatism. Furthermore, 18 (32%) children had amblyopia in both eyes, 13 (23%) had it in the right eye and 26 (46%) had amblyopia in the left eye.

	Magnitude of refractive error	Number of patients with amblyopia(%)
Myopia	<1.00	0
	1.25-2.50	7(11)
	>2.50	16(29.87)
Hypermetropia	<1.00	0
	1.25-2.50	8(11.68)
	>2.50	28(40.9)
Mixed Astigmatism	<1.00	2(3.24)
	1.25-2.50	2(3.24)
	>2.50	0

Figure 3 shows the distribution of refractive errors among amblyopic children in relation to the presence and type of associated strabismus.

Incidence of amblyopia was 19.09%(n=63), 68.5% of amblyopic children were unilateral and 31.5% bilateral.

**DISCUSSION**

Refractive errors are common in childhood. Vision 2020 has identified uncorrected refractive errors in children as a major area which needs immediate action.<sup>[3]</sup> Early screening of school-age children is necessary to discover the magnitude of refractive error and take corrective action such as organizing screening activities.<sup>[6]</sup> The purpose of our study was to assess the distribution and

patterns of refractive errors in children for the proper planning of screening & eye care camps.

In this study, refractive error was found in **64.4%** of the children. The reported prevalence of refractive error in different parts of the world showed a variation from **3.8% to 19.8%** as shown in Table 2.<sup>[6,7,8]</sup>

Study	Year	Age Group	Sample Size	Prevalence of RE (%)	Myopia (%)	Hypermetropia (%)
Al Wadaani <i>et al.</i>	2013	6-14	2000	14	65.7	12.4
Bardisi WM <i>et al.</i>	2002	5-15	1567	54	60.2	39.1
Chia A <i>et al.</i>	2010	7-14	507	33.8	62.9	15.7
Current Study	2019	5-15	512	64.4	60	44

The distribution of subtypes of refractive error among children shows that myopia was more common than hypermetropia. This is in concordance to other studies in which myopia was also the predominant type of refractive error.<sup>[5,9,10]</sup>

In our study, the prevalence of astigmatism was 16%, which was much lower than a study done in South India which had a prevalence of 20.4%. The reason for this may be that only mixed astigmatism was considered as a separate entity & compound astigmatism was reduced to the spherical equivalent in our study.<sup>[11]</sup>

The study also took into account ocular deviation associated with refractive errors. The prevalence of strabismus in our study was 37.87% (228). Around 22.5% of the children with myopia had some sort of ocular deviation, and around 90% (16 out of 18) had exotropia.

However, around 41% (205) of the children with hypermetropia had strabismus and 94% (193) of this number had esotropia. The explanation for this increased association of esotropia with hypermetropia more than myopia can be physiological phenomena: That is, the accommodation the hyperopic child has to make to focus an image on the retina stimulates convergence. Esotropia develops when fusional divergence is insufficient to compensate for this. Esotropia tends to occur more frequently in children with hypermetropia than emmetropia. Each diopter of increasing hypermetropia markedly raises the risk of esotropia.<sup>[13]</sup> Esotropia can be seen in 24% of cases of hypermetropia =+5.00 D, which would make the odds of having esotropia 122 times greater than in children with 0 to <+1.00 D of hypermetropia.<sup>[12]</sup>

The prevalence of amblyopia was 9% while its prevalence in population-based studies is estimated around 1.6–3.6%. In the current study, 68.5% of amblyopic children were unilateral and 31.5% bilateral. This is in line with similar studies<sup>[12]</sup> in which unilateral amblyopia is twice as common as binocular amblyopia. The majority of amblyopic children had mild to moderate compound hypermetropic astigmatism. These findings are consistent with findings from similar studies where a strong association of moderate hyperopic refraction with strabismus and amblyopia was found.<sup>[13,14]</sup>

## CONCLUSIONS

In this study, the incidence, magnitude & type of refractive errors, incidence of strabismus and amblyopia

have been studied. Myopia was the predominant refractive error in concordance to other studies in which myopia was also more common. There should be an emphasis on public education on the significance of early detection of refractive errors, and periodic screening in schools. This will help in the early detection and treatment of refractive errors, strabismus and amblyopia and thereby reduce the burden of disease, lessening prevalence of strabismus and amblyopia in children, improving quality of life.

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