

Original Article

The Association of Refractive Errors with Concomitant Strabismus and Amblyopia on Children Aged 2 Years to 12 years — A Cross Sectional Study in Kolkata, West Bengal

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Abstract

Background : Global estimates show, about 12 million children are visually disabled owing to errors of refraction, which if left uncorrected may lead to concomitant strabismus and amblyopia.

Aims and Objectives : The objectives of the study were to know the distribution patterns and different types of refractive errors in children along with their demographic details and to study the mutual associations of refractive errors, concomitant strabismus and amblyopia in the study group.

Materials and Methods : 493 eyes in 250 children 2-12 years of age were selected from patients attending Out Patients Department of Ophthalmology, Department in a Tertiary Medical Care Centre.

Results : Most common type of refractive error was Myopia (51.2%, n=128) and astigmatism was the least common type (9.6%, n=24). 39.2% (n=98) subjects were hypermetropic. Simple myopic type was the most common type (87.5% n=21) of astigmatism in study population. Strabismus was present in 22.8% of the study subjects (n=57). Esotropia was the most common type of strabismus associated with refractive errors. Amblyopia was present in 29 (11.6%) study subjects.

Conclusion : Most common type of amblyopia was anisometropic amblyopia.

Key words : Myopia, Hypermetropia, Esotropia, Exotropia.

Global estimates show, about 12 million children are visually disabled owing to errors of refraction¹. Hence, refractive errors were one of the priority areas for Vision 2020, a global initiative for prevention of preventable blindness introduced by the World Health organization². Different studies have reported a varied rates of prevalence for myopia (4.1%, 7.4%, 19.45%) and hyperopia (0.8%, 7.7%, 8.38%) in Indian children³⁻⁵. These studies confirm that many children are in need of spectacle correction which is often overlooked, specially in rural parts of India. Even global data suggests that, main causes of visual impairment are uncorrected refractive errors (Myopia, Hyperopia & Astigmatism) 43%, cataract 33%, Glaucoma 2%⁶. National estimates show, prevalence of concomitant strabismus in children varied from 2.3% to 6.0%^{3,5}. Strabismus causes loss of binocular vision, depth

Editor's Comment :

- The current study highlights the fact, that, even mild to moderate refractive errors can lead to strabismus leading to amblyopia.
- This makes parental awareness to be of utmost importance.
- Findings of this study may be utilized in formulation of strategies to limit onset of amblyopia in children, which can impact their future educational opportunities and employability.

perception and amblyopia, contributing thereby to pediatric visual impairment. Coupled with the fact, that, long term surgical success rate for strabismus is poor, strabismus adds to psychosocial consequences in terms of self-image, negative social prejudice, and even lower chance to get employed. Amblyopia develops if a young child fails to use one or both eyes normally. This happens due to poor development of neural mechanism of vision involving the brain. This visual loss is correctable only if appropriate measures are applied at appropriate time. The visual impairment usually becomes permanent if amblyopia is not treated before the age of about 7-8 years⁶.

The novelty of the present study is it has addressed children attending hospital for eye check-up rather than school students attending a class of a school in most of the other studies of the same kind. Besides, the current study is also unique, as it includes children younger than school going age, which has not been

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sufficiently dealt by other previous studies.

The present study aimed to study the association of refractive errors with concomitant strabismus and amblyopia in children aged 2 to 12 years attending a tertiary care hospital over the period of two and half years. The objectives of the study were to know the distribution patterns and different types of refractive errors in children along with their demographic details and to study the mutual associations of refractive errors, concomitant strabismus and amblyopia in the study group.

MATERIALS AND METHODS

This was a hospital based cross sectional observational study. Study period was from January, 2019 to June, 2021 (two and half years approximately). Place and setting of study was, it was conducted in Ophthalmology Outpatient Department of a Regional Institute of Ophthalmology, Medical College, Kolkata, West Bengal. Study population was newly diagnosed cases of refractive error (based on clinical examination, retinoscopy tests) were included in the study. Cases were selected from patients attending Out Patients Department. 493 eyes in 250 children (7 of them had unilateral refractive error) (based on Clinical examination, retinoscopy tests) with refractive errors were selected from patients attending Out Patients Department of a tertiary Medical Care Centre. The sample size was calculated using online statistical software⁷ setting the parameters of 95% confidence interval and 5% as the margin of error. Institutional Ethics Committee approval vide Ref No MC/KOL/IEC/NON-SPON/172/11-2018 Dated 22.12.2018 was obtained prior to study. Parental informed consent and assent forms (both verbal and written as applicable) were obtained in each case as per ICMR guidelines.

Children aged 2 years to 12 years being newly diagnosed with refractive error (both unilateral and bilateral) were included in the study. Subjects with history of ocular trauma, presence of cataract in either or both eye, patients having disease of anterior segment, orbit, adnexa, posterior segment, patients having history of previous intraocular surgery, presence of any systemic illness, incomitant squint, patients not willing to take part in the study, or having congenital anomalies were excluded from the study.

Total number of children screened were 300 children. Out of which 250 met inclusion criteria.

Patients attending ophthalmology Outpatient Department with complaint of dimness of vision or routine eye check-up (in small children) were

subjected to complete Ophthalmological examination. After examination, patients meeting the inclusion criteria were recruited for the study. Detailed information about the study was given to the participants (for grown up children) and their parents/legal guardians in clear, understandable words and proper written informed assent was taken. The selected subjects underwent the detailed ocular examination. Anterior segment was examined using slit lamp biomicroscopy and the posterior segment was examined using Indirect Ophthalmoscope. Best Corrected Visual Acuity (BCVA) was measured by Snellen's Chart and Logmar chart (using Lea's symbol for children who could not read). Retinoscopy was used for conducting objective refraction in all children.

All measurements were taken independently by two of the authors (Author 2 and 3). The reason for taking measurement twice was to reduce the chance of human error while doing objective refraction by retinoscopy in children. It is also difficult to get cooperation from small children to perform the test. Severity of refractive error was determined.

Statistical analysis plan : The collected data was entered for analysis in Microsoft Excel. Descriptive statistics (mean, standard deviations and range) were employed to describe continuous variables, while frequency distributions were obtained for dichotomous variables. The intraclass correlation coefficient of the investigators for inter-rater reliability, measured using SPSS software was 0.92 with 95% confidence interval.

RESULTS

A total of 250 children were enrolled for the study out of which 7 children had unilateral refractive error. Hence, 493 eyes of 250 children were studied. Out of the total 250 children, 142(56.8%) were male and 108(43.2%) were female. A male : female ratio of 1.31:1. Majority went to private school. Majority (54%) were from urban areas. Mean age of study participants was 7.07 ± 2.58 . Most common type of refractive error was Myopia (51.2%, $n=128$) and astigmatism was the least common type (9.6%, $n=24$). 39.2% ($n=98$) subjects were hypermetropic. Simple myopic type was the most common type (87.5% $n=21$) of astigmatism in study population. Strabismus was present in 22.8% of the study subjects ($n=57$).

Among the children with myopia, 23 had some sort of ocular deviation, and around 90.5% (19 out of 23) had exotropia. However, around 34.6% of the children with hypermetropia had strabismus and 90% of this number had esotropia. All cases of strabismus belonged to the concomitant variety as the angle of

squint did not vary with direction of gaze.

Esotropia was the most common type of strabismus associated with refractive errors (63.2%, n=36). Mean age of onset of strabismus was 3.02 ± 1.46 years. Amblyopia was present in 29 (11.6%) study subjects. Most common type of amblyopia was anisometropic amblyopia (62.1%, n=18). More than half of the study subjects had a family history of refractive error (52.4%, n=131). Majority of the subjects had visual acuity ranging from 6/6 to 6/12 (29.8%, n=149). Most of the children suffered from mild to moderate degree of refractive error in all categories. Overall, 64.75% children were having mild ($\leq 1.5D$) refractive error whereas only 1% children were having very severe refractive error of more than 5D.

DISCUSSION

Most of the previous studies done to analyse the pattern of refractive errors in children are either school screening or population based and require huge economic resources^{8,9}. The present study being a hospital-based study is unique as it has been conducted in the OPD premises without the need of extra manpower and equipment's.

The prevalence of refractive errors was slightly higher in males as compared to females, though this difference was not statistically significant. Comparable result was reported in a hospital-based study done by Matta S, *et al* in New Delhi¹⁰. In the population based study done by Dulani N, *et al* in Jaipur, Rajasthan female preponderance was seen⁸. Results of the study done by Pavithra MB, *et al*⁹ in Bangalore also reported that females are more affected by refractive errors, which is not comparable with the present study. This shows that in hospital based studies like the present study, a male preponderance was observed. On the contrary population-based studies showed a female predilection for refractive errors. The reason for this difference is not clear, but the possible cause of this difference may be ignorance towards the needs of female child or may be due to the social stigma linked use of spectacles by females.

In the present study strong family history of refractive

error was present. The association between family history of refractive error in parents or siblings was significant in the studies conducted by Pavithra MB, *et al*⁹ and Hashemi H, *et al*¹¹. This indicates a relationship between refractive errors and heredity.

Myopia (51.2%) was the leading cause of refractive error in the study population. In a survey conducted by Lin LL, *et al*¹² in Taiwan to study the prevalence among school children, the rate of myopia increased from 20% at 7 years, to 61% at 12 years, and 81% at 15 years. In the study by Niroula, *et al* on school going children in Nepal, prevalence of myopia was 4.05%, hyperopia (1.24%) and astigmatism (1.14%)¹³. In the present study the uncorrected visual acuity in one or both eyes at the time of presentation was better than 6/12 in 54% eyes, 6/18 to 6/36 in 41.8% eyes and less than or equal to 6/60 in 4.2% eyes. Similar results were obtained by Niroula, *et al*¹³ in their study. Hence, majority of children with refractive error present with mild to moderate decrease in visual acuity ($\leq 6/36$). In the present study, the prevalence of astigmatism was 9.6%, which was much lower than a study done by Matta S, *et al* in New Delhi¹⁰, where it was found to be 27.4%. However the latter study was carried out in adolescents. Pavithra MB, *et al*⁹ noted a low prevalence of astigmatism (1.6%), similar to the present study most likely because of a similarity in age structure of the subjects undergoing study. Table 1 outlines the comparative data pertaining to the prevalence of refractive errors of previous studies.

Zhang XJ, *et al*¹⁴ and Hashemi H, *et al*¹⁵, in their population based have reported a lower prevalence of strabismus. As per Zhang XJ, *et al* Strabismus is most commonly associated with hypermetropia (Odds Ratio 2.56) followed by anisometropia (odds ratio of 2.47). From a physiological perspective, one can explain the increased association of esotropia with hypermetropia. There is an increased accommodative effort by the hyperopic child to focus an image on the retina stimulating convergence, hence leading to esotropia in long term. This is called fusional divergence insufficiency.

The prevalence of amblyopia in this clinic based study was considerably higher (11.6%) while its prevalence

Table 1 — Comparison of study findings.

Author	Place of study	Sample size	Study Population	Prevalence of Myopia	Prevalence of Hypermetropia	Prevalence of Astigmatism
Matta, <i>et al</i> ¹⁰ , 2006	New Delhi	1000	12-17 years	55.6%	16.9%	27.4 %.
Dulani N, ⁸ 2014	Rajasthan	928	5-18 years	63.47%	11.35%	25.18%
Pavithra MB ⁹ , 2013	Bangalore	1378	7-15 years	4.4%	1.03%,	1.6%
Hashemi H, <i>et al</i> ¹¹ , 2014	Iran	451	14-21 years	29.3%	21.7%	20.7%
Niroula DR ¹³ , 2009	Nepal	964	10-19 years	4.05%	1.24%	1.14%
Present Study, 2025	Eastern India	250	2-12 years	51.2%	39.2%	9.6%

in than a school based population study by Ganekal S, *et al* (1.1%)¹⁶. Unilateral amblyopia is far more common than bilateral amblyopia as reported by McKee SP, *et al*¹⁷. Findings of the present study were similar in this regard which showed, 68.5% of amblyopic children were unilateral and 31.5% bilateral. 0 to 7 years is considered to be the most vital time for development of vision. Strabismus developing during such period can cause amblyopia¹⁸.

In the current study most of the children suffered from mild to moderate degree of refractive error in all categories. Myopia up to 2.75D and hypermetropia as well as astigmatism up to 1.5 D was present in majority of the eyes. This finding is in agreement with studies by Hashemi H, *et al*¹⁸ and Krishnamurthy H, *et al*¹⁹.

The current study highlights the need of parent education on association of amblyopia with strabismus and refractive errors. Parents often overlook the urgent need of early diagnosis and proper management of childhood refractive errors, even the mild to moderate ones, in order to prevent development of amblyopia and its sequelae. Awareness campaigns utilizing social media can prove to be a feasible approach to solve this problem.

Limitations of the study :

The size of the study population is a limitation of the study. The result would have been more reliable if it was done in a bigger sample size. Another limitation of the study is the population chosen for the study was children attending hospital, which increases the possibility of getting more number of children having visual disturbances to get included in the study and the number not exactly representing the prevalence in general population. If the study population was chosen from the community, it would have been more representative of the general population.

CONCLUSION

The current study highlights the fact, that, even mild to moderate refractive errors can lead to strabismus leading to amblyopia. This makes parental awareness to be of utmost importance. The study also shows the epidemiology of refractive errors with its sequelae, in the Eastern part of India in a pre-dominantly urban setting. Findings of this study can be utilized in formulation of strategies to limit onset of amblyopia in children, which can impact their future educational opportunities and employability.

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