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Original Research Article

Changing trend in prevalence of refractive errors: a hospital-based study

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ABSTRACT

Background: Refractive errors are the second most common reason of blindness in India after cataract. It accounts for 33.3% of cases of childhood blindness. The purpose of this study was to estimate the prevalence of refractive error and related visual impairment in children visiting a tertiary care eye center in Southern India.
Methods: This was hospital-based descriptive study. Children <15 years of age with significant refractive error were included in the study. They were examined for visual acuity measurements, ocular motility evaluation, retinoscopy and autorefraction under cycloplegia, and examination of the anterior segment and fundus. Significant refractive error was defined as myopia ≥-0.75D, hypermetropia >+2D and astigmatism >0.75D. Descriptive statistics with frequency, mean±Standard deviation were computed for better and the worse eye. Statistical tests were applied between the worse and better eye using Chi square test.
Results: A total of 946 children were screened. The mean age was 10.5±6.2 years (3-15 years) with 503 (53.2%) males and 443 (46.8%) females. With respect to vision in the worse eye; 54.01% (n=511) had moderately subnormal vision. One hundred and twenty- two children (23.4%) of <10 years, and 351 (67.4%) of ≥10 years group had myopia, with statistically significant difference (p<0.001). The reverse pattern was seen with respect to hypermetropia and astigmatism. Prevalence of amblyopia was found to be 8.6%.
Conclusions: Though myopia is more prevalent among general population, prevalence of astigmatism is higher among children attending an eye hospital and uncorrected astigmatism is the most significant amblyogenic factor in refractive amblyopia.

Keywords: Astigmatism, Prevalence, Refractive error

INTRODUCTION

Refractive errors are the second major reason behind blindness in India after cataract and therefore one of the commonest reasons for patients to consult ophthalmic assistants or ophthalmologists. Over a quarter of the outpatient attendance at all eye clinics and hospitals is due to refractive errors.[1] It is estimated that there are 1.4 million blind children in the world.[2] An additional seven million suffer from low vision and an extra ten million children have a correctable refractive error inflicting visual impairment (refractive bilateral acuity of <6/18). The prevalence of blindness in children in India is estimated to be 0.8/1000 children in the age group of 0-15 years, though no population-based nation-wide survey has been undertaken yet. Currently, there are an estimated 270,000 blind children in India.[2,3] Amongst children outside blind schools, refractive errors are important causes of visual impairment and blindness.[2,3] Myopia is one of the commonest causes of visual impairment, which is usually acquired and nearly always progressive. It

rarely occurs before the age of 5 years and new cases appear throughout childhood and adolescence, particularly between the ages of 6 to 15 years.[4] Poor vision during childhood not only affects the performance in school but also has a negative influence on their development and maturity. Most school going children do not realize that they are suffering from the ocular disability as they can adjust to poor vision in different ways; for example, sitting closer to the blackboard, holding their books close to their eyes, or squeezing their eyes. They may also tend not to undertake any work that needs visual concentration, thus affecting their performance.[5]

In India, varied prevalence rates of myopia and hyperopia have been reported in children.[6,8] These studies have confirmed that many children are in need of spectacle correction and in rural India, around 86 per cent of children presented without correction for refractive error.[6,8] In studies done so far, myopia has mostly been the center of interest.[9,10]

The objective of this study is to estimate hospital-based prevalence of refractive errors among children (≤ 15 years of age) from an urban population in Southern India.

METHODS

This hospital based prospective study was conducted at a tertiary eye care centre located in central Bangalore (Narayana Nethralaya, Ashoknagar branch, Karnataka, South India) over a period of one year from August 2016 till July 2017. Children less than 15 years of age were considered for the study.

Those with previous history of ocular surgery or trauma, children who were not co-operative for refraction, those with congenital anterior segment abnormalities, those who presented with asthenopic complaints or diagnosed with spasm of accommodation were excluded from the study.

Every child underwent a standard examination routine. History pertaining to present and past ocular problems and treatment, history of any medical or surgical treatment, and family history was obtained. Visual acuity was measured at 6 metres by an optometrist, using a digital vision logMAR chart and was recorded as the smallest line read with one or no errors. Both the eyes were tested in tandem, both with (presenting visual acuity) and without (uncorrected visual acuity) spectacles, if the parents had brought them. Lensometer was used to measure the spectacles' power. Cover test was performed for near (33 centimeters) and distance (6 metres) and tropias were classified as esotropia, exotropia, or vertical deviation and the degree of tropia was measured using the prism bar cover test.

Pupil were dilated with 2 drops of 1% cyclopentolate and one drop of 0.8% tropicamide+ 5% phenylephrine, administered 5 minutes apart. Light reflex and pupil dilation were evaluated after 45 minutes. Refraction was performed by an optometrist, regardless of visual acuity using a streak retinoscope. Children with uncorrected visual acuity of 6/9 or worse in either eye underwent subjective refraction. The anterior segment was examined using a slit lamp and the fundus was evaluated with the help of an indirect ophthalmoscope.

Significant refractive error was considered to be myopia of ≥-0.75D, hypermetropia of more than +2D, astigmatism cylindrical error of more than 0.75D.[11] Amblyopia was defined as unilateral or bilateral subnormal vision, at least two lines less than normal or two lines less than the fellow eye in unilateral cases.[12] The degree of subnormal vision was categorized as mild (6/9-12) moderate (6/15-6/36) and severe (worse than 6/36). The study was approved prior by the Institutional Ethics and Review Board and adhered to the provisions of the Declaration of Helsinki for research on human participants.

Data collected was entered in an excel format. Descriptive and analytical statistics were computed. The statistical analysis was done with the SPSS version 22 (IBM Corporation, SPSS Inc., Chicago IL, USA). Children's age was dichotomized as <10 and ≥10 years, for comparison of prevalence. Descriptive statistics with frequency mean±Standard deviation were computed for the worse and better eye. The eye with better vision was considered as 'better eye'. In case the vision was same in both the eyes; the eye with higher spherical error was considered the worse eye. Statistical tests were applied between the worse and better eye using Chi square test for proportions with 95% confidence interval.

RESULTS

A total of 946 children were screened. The mean age of presentation was 10.5±6.2 years, with a range of 3 to 15 years. There were 503 (53.2%) males and 443 (46.8%) females. Uncorrected visual acuity could not be recorded in 91 (09.6%) children. Forty-one children out of 946 (4.3%) had unilateral refractive error and 367 were freshly detected cases, accounting for 38.8% of total cases.

Better eye

Sixty-two children (6.6%) had 6/6 vision at presentation. There was statistically significant difference (p<0.001) between age distribution and visual acuity in the better eye, indicating significantly higher prevalence of refractive error in children ≥10 years. There was no statistically significant difference (p=0.13) between gender distribution and visual acuity in the better eye, Table 1.

Table 1: Presenting visual acuity in the better eye and worse eye.

Presenting visual acuity in the better eye							
Uncorrected visual acuity	**Number (%) (n=946)**	**Distribution by age**			**Distribution by gender**		
		<10 years (%) (n=438)	**≥10 years (%) (n=508)**	**P value**	**Males (%) (n=503)**	**Females (%) (n=443)**	**P value**
Normal (6/6)	62 (06.6)	23 (05.3)	39 (07.6)	<0.001 (0.000-0.003)	32 (06.4)	30 (06.7)	0.13 (0.153-0.202)
Mild (6/9-6/12)	269 (28.4)	153 (34.9)	116 (22.8)		148 (29.4)	121 (27.3)	
Moderate (6/12-6/36)	413 (43.7)	191 (43.7)	222 (43.7)		223 (44.3)	190 (42.8)	
Severe (>6/36)	111 (11.7)	21 (04.8)	90 (17.7)		51 (10.1)	60 (13.5)	
Not available	91 (09.6)	50 (11.4)	41 (08.1)		49 (09.7)	42 (09.4)	
Presenting visual acuity in the worse eye							
Uncorrected visual acuity	**Number (%) (n= 946)**	**Distribution by age**			**Distribution by gender**		
		<10 years (%) (n=438)	**≥10 years (%) (n=508)**	**P value**	**Males (%) (n=452)**	**Females (%) (n=401)**	**P value**
Mild (6/9-6/12)	159(16.8)	91 (20.7)	68 (13.4)	<0.001 (0.000-0.003)	78 (17.3)	81 (20.2)	0.14 (0.122-0.182)
Moderate (6/12-6/36)	511(54.0)	261 (59.6)	250 (49.2)		285 (63.1)	226 (56.4)	
Severe (>6/36)	183(19.3)	34 (07.7)	149 (29.3)		89 (19.7)	94 (23.4)	
Not available	91 (09.8)	50 (11.8)	41 (08.1)		51 (10.2)	42 (9.5)	

Table 2: Prevalence of refractive error in the worse eye.

Uncorrected error	**Number (%) n=1,477**	**Distribution by age**			**Distribution by Gender**		
		<10 years (%) n=545	**≥10 years (%) n=628**	**P value**	**Males (%) n=264**	**Females (%) n=258**	**P value**
Myopia (-1D)	521 (55.1)	122 (23.4)	351 (67.4)	<0.001	243 (92.4)	231 (89.5)	0.22
Hypermetropia (+2D)	177 (18.7)	56 (31.6)	26 (14.7)	<0.001	46 (47.9)	36 (44.4)	0.03
Astigmatism (-1D)	779 (82.3)	367 (47.1)	251 (32.5)	<0.001	342 (82.1)	276 (76.2)	<0.001

Table 3: Descriptive statistics for refractive errors in the worse eye.

Refractive error	**N**	**Mean, SD**	**Median**	**Mode**	**Range**
Myopia	521	-2.75, 1.65	-1.89	-2.50	-1, -9.5
Hypermetropia	177	+3.25, 1.85	+2.50	+2.25	+2, +8
Astigmatism	779	-1.25, 0.25	-2.35	-1.50	-1, -3.50

Worse eye

With respect to the vision in the worse eye; most of them had moderately subnormal vision; 261 (59.6%) and 250 (49.2%) in children <10 and ≥10 years respectively (Table 1).

There was statistically significant difference (p<0.001) between age distribution and visual acuity in the worse eye, again indicating significantly higher prevalence of refractive error in children ≥10 years. Two hundred and eighty-five males (63.1%) and 226 (56.4%) females had moderately subnormal vision with no statistically significant difference.

Refractive error

Prevalence of refractive error in the worse eye is shown in Table 2. Five hundred and twenty-one children (55.1%) had myopia. One hundred and twenty-two children (23.4%) in less than 10 years group and 351 (67.4%) children in 10 years and above group had myopia, with statistically significant difference (p<0.001); indicating more prevalence in the older age group.

With respect to hypermetropia, children in less than 10 years group had higher prevalence 56 (31.6%) as compared to children in 10 years and above group, i.e.; 26 (14.7%) with a statistically significant difference

(p<0.001). A similar pattern was observed for astigmatism.

With respect to the gender, males had a higher prevalence of myopia 243 (92.4%); hypermetropia 46 (47.9%) and astigmatism 342 (82.1%) as compared to females, with a statistically significant difference for hypermetropia (p=0.03) and astigmatism (p<0.001).

Table 3 shows the descriptive statistics for refractive errors in the worse eye. Mean and standard deviation for myopia, hypermetropia and Astigmatism was -2.75, 1.65; +3.25, 1.85; -1.25, 0.25 respectively. (Figure 1) The line graph showing the prevalence of all three refractive errors over a period of year; clearly indicates the higher prevalence of astigmatism.

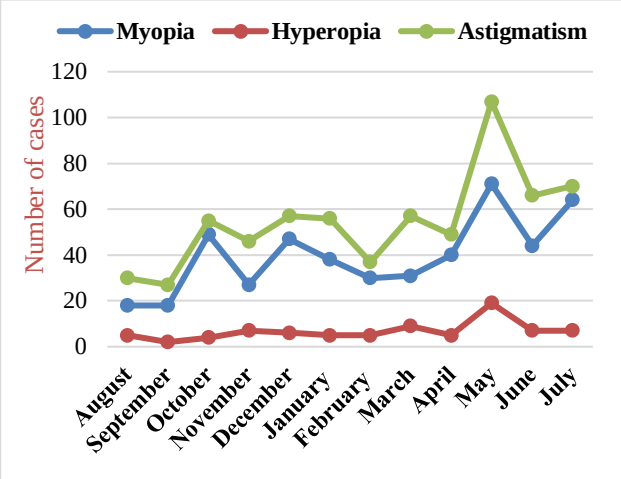

Figure 1: Line graph of prevalence of refractive errors.

Associated ocular conditions

One hundred ninety-eight children had associated ocular conditions. Refractive amblyopia had highest prevalence 83 (41.9%); followed by squint 69 (34.8%); allergy 26 (13.13%) and others 20 (10.10%). 'Others' included anterior segment conditions (keratoconus, developmental cataract), posterior segment conditions (optic nerve head drusen, lattice retinal degeneration), albinism, down's syndrome and color blindness.

Table 4 highlights the characteristics of refractive amblyopic children. Eighty three percent of 83 amblyopic children were less than 10 years of age. Girls and boys were almost equally affected. Around 43% of cases were unilateral due to anisometropia. Most of them had moderately subnormal vision (71.08%).

This pattern was similar to that seen in the entire cohort. With respect to the refractive error, 45 children had astigmatism, 27 were myopic and only 11 children had hypermetropia.

Table 4: Characteristics of refractive amblyopic children.

Characteristics		N
Age groups (in years)	<5	29
	5-10	40
	>10	14
Gender	Boys	43
	Girls	40
Laterality	Unilateral	36
	Bilateral	47
Refractive error	Myopia	27
	Hypermetropia	11
	Astigmatism	45
Vision in worse eye	6/9 - 6/12	4
	6/15 - 6/45	59
	>6/60	20

DISCUSSION

Most of the studies done so far to analyze the pattern of refractive errors in children have either been school screening or population based and they require large economic resources. Since this was a hospital-based study, it was easy to conduct it in familiar OPD premises without any extra manpower or equipment. Being a hospital-based study, this study had a greater number of children with refractive errors within the given study period (i.e, 946 as compared to 898 highest among the population-based studies and 582 highest among the school-based studies).[11] Dandona et al screened 1726 patients but they had included patients till 99 years of age in their study and Saxena et al included 1,297 patients but their aim was to find the prevalence of myopia in a group of population.[8,9] Authors used a logMAR digital vision chart to assess the vision and every child in this study underwent dilated retinoscopy to confirm the refractive error. Authors referred to the cut off points as recommended by Sheeladevi et al to consider a refractive error significant (myopia of ≥-0.75D, hypermetropia of more than +2D, astigmatism cylindrical error of more than 0.75D).[11]

In thin study, 503 (53.2%) children were males and 443 (46.8%) were females. The prevalence of refractive errors was found to be slightly higher in males, though the difference was not statistically significant. Similar results were reported in hospital-based study done by Mittal et al in Uttarakhand and Matta et al in New Delhi.[13,14] In population-based studies done by Dulani et al in Jaipur, Pavithra et al in Bangalore and Prema et al in Tamil Nadu females were reported to be more affected, which is contrary to this study.[15-17] Mittal et al postulated that the possible cause of this difference may be ignorance towards the needs of female child or may be due to the social stigma associated with spectacle use in females.[13]

In this study the average age of presentation was 10.5±6.2 years. Similar results were reported by Mittal et al in

Uttarkhand,13 where the average age of presentation was found to be 10.90±3.16 years and by Kalikivayi et al in Hyderabad (9.3±3.4 years).[18]A higher mean age of presentation was reported by Pavithra et al in Bangalore and Hashemi et al in Iran.[16,19] But, the minimum age of children included in these studies was higher too.

In this study, 83 out of 946 children with refractive error (8.8%) children were found to have amblyopia. Similar prevalence of amblyopia was found in study done by Mittal et al (7.07%) and Pant et al in Nepal (7.62%).[13,20] This is in contrast to the estimated cumulative incidence of amblyopia, i.e.; 2% to 4% in children aged up to 7 years.[21] This is probably because this was a hospital based study. This too emphasizes the need to look for amblyopia in children presenting with refractive errors. Astigmatism was found to be the most common refractive error resulting in amblyopia in previous studies as well.[22-24] Daigavane et al in their study on Indian population found 13 children to have amblyopia 53% were refractive and 23% were strabismic.[25] In a study by Mittal et al, the numbers were 60.71% and 39.29%, respectively.[13]

In this study, 69 out of 946 children with refractive error (7.3%) children were diagnosed with squint. Mittal et al also found a similar prevalence of strabismus (6.06%).[13] However, a higher prevalence of 13.3% was found by Kalikivayi et al in Southern India.[18] But the association of strabismus with refractive errors was not found to be significant and this difference may be due to different inclusion criteria. Authors also found esotropia to be the most common type of squint, similar to Mittal et al.[13]

The present study, 61.2% of children were already using spectacles. A similar prevalence was observed in studies done by Rai et al and Dulani et al.[15,26] However, Mittal et al reported that only 21.70% children in their study were already using spectacles.[13] The authors postulated that this difference was probably because of lack of awareness or shyness to wearing spectacles in their area.

In the present study, majority of patients (54%) presented with moderately low vision. The vision was better than 6/12 in only 16.8% and worse than 6/36 in 19.3% of children. This is in contrast to study done by Mittal S et al done in Uttarakhand and Sethi et al in Pakistan.[13,27] Mittal et al found the uncorrected visual acuity to be better than 6/12 in 48.27% eyes, 6/18 to 6/36 in 33.80% eyes and less than or equal to 6/60 in 17.93% eyes.[13] Mittal et al included the presenting vision of both the eyes to study the prevalence of low vision while authors only considered the vision in the worse eye for the ease of presentation.

In this study the prevalence of myopia was 55.1%, hypermetropia 18.7% and astigmatism 82.3%. Mittal et al also reported similar pattern; myopia 41.23%, hypermetropia 11.78% and astigmatism 46.99%.[13] Most of the Indian studies, have reported higher prevalence of myopia, the highest being 91% by Basu et al Dandona et al and Murthy et al are one of the few studies that have reported a higher incidence of hypermetropia; 95.3% and 51% respectively.[7,8,28-30] Though it is difficult to draw direct comparisons between the studies due to the differences in screening protocols; authors found a significantly higher percentage of astigmatism as compared to myopia; which has been the primary focus of most of the studies. The percentage of refractive error that authors found in this study was similar to the study by Dandona et al though authors had a larger number of children included in this study.[6]

Though the prevalence of myopia may be higher among the Indian population, astigmatism is more prevalent among those seeking ophthalmic consultation. The study done by Mittal et al was also hospital based.[13] The authors explained this pattern by the fact that all children were school going and most of them complained regarding difficulty to see the blackboard in the classroom. Hypermetropic children can accommodate to see clearly while it is not possible in case of myopia and astigmatism, and these children sought ophthalmologist's advice.[13]

Another interesting finding was the higher prevalence of hypermetropia and astigmatism in children <10 years of age as compared to older children. Myopia was more prevalent in children older than 10 years. This is in accordance to the fact that myopia rarely occurs before the age of 5 years and new cases appear throughout childhood and adolescence, particularly between the ages of 6 to 15 years.[4] Similar age-related shift from hyperm-etropia to myopia was reported by other national and international studies.[7,18,31,32]

It was also interesting to note that, all the patients who had allergic eye disease had an astigmatic refractive error.

This study is based on the data collected from children attending a tertiary eye care center in central Bangalore; hence the results may not be reflective of the general population. This may be viewed as a limitation.

CONCLUSION

To conclude, this study shows that clinically significant astigmatism is more prevalent than myopia among children attending a tertiary eye care center and uncorrected astigmatism is the most significant amblyogenic factor in refractive amblyopia. A community-based study will help test these findings in the general population.

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