Pattern of Refractive Error and Visual Impairment Due to Uncorrected Refractive Error among the Pediatric Populations Attending Ophthalmology Department of a Tertiary Care Hospital in Dhulikhel, Kavre

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Citation

Kaiti R, Shrestha J, Shrestha P, Shrestha R, Shrestha GS, Kondal N, et al. Pattern of Refractive Error and Visual Impairment Due to Uncorrected Refractive Error among the Pediatric Populations Attending Ophthalmology Department of a Tertiary Care Hospital in Dhulikhel, Kavre. *Kathmandu Univ Med J.* 2025; 92(4): 512-7.

ABSTRACT

Background

The refractive error is an anomaly of the dioptric system of the eye in which rays of light are not focused on the retina.

Objective

To ascertain the pattern and prevalence of refractive error and visual impairment secondary to it in the pediatric population attending to ophthalmology department of Dhulikhel hospital.

Method

This was a hospital-based, prospective, cross-sectional study design. Presenting visual acuity, age of presentation, refractive status, best corrected visual acuity, and status of visual impairment were assessed in children ranging from 3-15 years presenting to the Ophthalmology department of Dhulikhel Hospital within the period of 6 months. They underwent assessment of visual acuity in different charts (as per their co-operation level) and cyclorefraction. History of use of spectacle was noted, and the children were categorized into different visual impairment categories as per their presenting visual acuity. Paired t-test was used to assess the improvement in visual acuity, post-refractive error correction.

Result

Out of 1,498 children examined during the study period, 116 (7.74%) had refractive error. Among these 60 (51.70%) were females and 56 (48.30%) were males. The mean age at presentation was 11.45±3.62 years. Astigmatism was the most common subtype seen in 45.26% (N=105 eyes), followed by Myopia (42.67%, N=99 eyes) and Hypermetropia (11.21%, N=26 eyes). Only 36.20% (N=42) of the pediatric population were using spectacle. 62.90% (N= 73 children) had some of visual impairment during their presentation. There was statistically significant improvement in visual acuity after refractive correction (paired t-test, $P<0.001$).

Conclusion

Refractive errors were common among children with astigmatism having highest prevalence and majority presenting with visual impairment. Lack of awareness, infrequent ocular examination and lack of vision screening were the main causes for the late presentation. So, early detection through screening programs and timely management is recommended to enhance quality of life.

KEY WORDS

Astigmatism, Refractive error, Spectacle, Visual impairment

INTRODUCTION

Uncorrected refractive error, a major cause of global visual impairment, accounts for 2.3 billion affected individuals.[1] Contemplating the greater proportion of casualties, World Health Organization adopted "Vision 2020: the right to sight" with the major aim of correcting refractive errors among developed and developing countries. It is the second leading cause of treatable blindness.[2] Onset of the condition at an early age, not only hampers a child's academics and productivity, but also degrades overall quality of life.[3,4] Higher preponderance of refractive error among children can be directly correlated with the depreciating socio-economic status of the nation, as the years of blindness is higher compared to other ocular conditions with late onset like cataract. While, Nepal blindness survey of 1981 didn't even include refractive error on its etiology list, mid-term review on 2010 presented 4% of the total blindness to be caused by refractive error with about 10% prevalence among pediatric population. At the meantime, school-based study conducted on 2002, presented refractive error as a primary cause of ocular morbidity with the frequency of 8.1%.[5] RESC series also reported prevalence of 56% in Nepal, 94.9% in China and 61% in India.[6-8] The trend of elevating prevalence was significant worldwide, with 12 million children having uncorrected refractive error among 19 million children with visual impairment.[9]

Pediatric populations are more vulnerable as they are unable to communicate their visual issues to the parents, leading to delayed diagnosis. Although refractive error are treatable, late correction can lead to amblyopia and other comorbidities. In long term, the deprivation from eye health service can impede learning, social interaction and overall socio-cognitive development of the children as well as the economic prosperity of the society. Thus, early diagnosis, appropriate management, and timely referral is crucial. Although highly remediable, the major barriers for correction remains stigma, ignorance, and negligent parents even when spectacles are prescribed.

METHODS

A hospital based cross sectional study was carried out among patients of age 3 to 15 years, who visited the Ophthalmology department of Kathmandu University Teaching Hospital from December 1, 2015 to May 30, 2016 (total of six months). Subjects not willing to participate in the study, subjects having other ocular morbidities (other than refractive error) in the eye responsible for diminished vision like any retinopathy, squint, significant cataract, aphakia, pseudophakia and others were excluded from the study. Informed and written consents were taken from all subjects and his/her attendants after briefing the purpose of the study.

Assessment included the followings:

a) Presenting visual acuity and best corrected visual acuity for distance were measured using different charts (LogMAR chart, Sheridan-Gardiner chart and Kay picture chart) as per the co-operation level of the subjects. Visual acuity in children who could read out the alphabets were tested in LogMAR chart specially designed to measure at 10 feet under normal room illumination. It is an alphabet chart having a consistent number of five letters in each row. There is a geometric progression of 0.1 log unit in each line. For the subjects, who were just the beginners in preschool and could not read out alphabets were tested in Sheridan-Gardiner chart (tested at 20 feet) and Kay picture chart (tested at 10 feet).

Presenting visual acuity was noted as the patient presented, aided or unaided. History of spectacle use was noted. Best corrected visual acuity was noted after cycloplegic correction in all cases.

b) Objective and subjective refraction was done for best achievable acuity with glass for distant vision. Both objective and subjective refraction were carried out by optometrists. Cycloplegic refraction was carried out with cyclopentolate eye drop (1%) following Havner's dose. Patients were subjected to streak retinoscopy at a working distance of 50 centimeters performed with the help of Heine streak retinoscope. Subjective refraction was done after 3 days of wet retinoscopy and spectacles were prescribed as per the acceptance.

The following criteria were used to classify the refractive error

a) Hypermetropia: if refractive error is of magnitude ≥+0.50 D. This was further classified as **low hypermetropia** (>+0.50D to <+ 3.0D), **moderate hypermetropia** (>+3.0 D to <+6.0D) and **high hypermetropia** (>+6.0D).

b) Myopia: if refractive error is of magnitude ≥-0.50D. This was further classified **as low myopia** (>-0.50D to < -3.0D), **moderate myopia** (>-3.0D to <-6.0D) and **high myopia** (>-6.0D).

c) **Astigmatism:** any cylindrical error ≥±0.5. Astigmatism was further classified as simple myopic astigmatism, simple hyperopic astigmatism, compound hypermetropic astigmatism, compound myopic astigmatism and mixed astigmatism.

Astigmatism was further classified as "with the rule "when myopic astigmatism had axis at 180±30 degrees or hypermetropic astigmatism had axis at 90±30 degrees and "against the rule" when myopic astigmatism had axis at 90±30 degrees or hypermetropic astigmatism had axis at 180±30 degrees. If the axis of astigmatism was within >30 to <60 or >120 to <150 degrees, it was considered as oblique astigmatism.

Visual impairment due to uncorrected refractive error was classified according to the presenting visual acuity which

might be the uncorrected (visual acuity in uncorrected refractive error) and corrected (visual acuity with present correction in patients using spectacle). Visual impairment was further classified as:[10]

Normal Vision- 20/10-20/25

Mild Visual Impairment- 20/28-20/60

Moderate Visual Impairment- 20/70 – 20/160

Severe Visual Impairment- 20/200- 20/400

Profound Visual Impairment – 20/500-20/1000

Near Total Visual Impairment - < 20/1000

Total Visual Impairment – No light Perception

Visual acuity for the classification of visual impairment was taken of better eye with best correction.

c) Detail Orthoptic evaluation was performed in all cases to exclude the cases with reduced visual acuity due to strabismus, eccentric fixation, and other binocular single vision disorders those can affect visual acuity. Alignment of eyes was assessed by Hirschberg's test, krimsky test and cover/uncover test. Cover/uncover test was performed with the help of an occluder and a fixation target for near and distance. Prism cover test was performed for those having phoria or tropia. Fixation Pattern was assessed by the Linkz star configuration of the standard Heine's direct Ophthalmoscope. Binocularity in the cases was assessed using red-green glass and worth four dot test (WFD) after full correction of refractive error if any present.

d) Anterior segment and Fundus were assessed with the help of Haag-Streit Slit lamp to rule out any physical and organic causes. Fundus was evaluated after dilation with the Cycloplegics.

Use of optical correction previously was also noted. The Log MAR values for presenting visual acuity and best corrected visual acuity was noted and analyzed to see mean improvement in visual acuity after best correction.

Responses were anonymized and participants (children and parents) were made aware of this fact before participation in the study. The data collected will not be accessible to anyone else other than the researcher. The names and status of all the participants will be strictly confidential.

Written consent was taken from each child and parent prior to enrolling in the study. Ethical clearance was also obtained for the study from the Institutional Review Committee (IRC-KUSMS 24/15) before conducting this study.

Data was entered and analyzed on SPSS 16 version. Descriptive tabulations along with frequency, percentage, mean and standard deviation was applied to generate descriptive information. While Chi-square test was used to analyze the association between the categorical variables and paired t-test was applied to compare the presenting visual acuity with the best corrected visual acuity. 95% of confidence interval was calculated and p value <0.05 was considered statistically significant.

RESULTS

There were 1,498 total pediatric subjects during the time of the study. Pediatric patients with refractive error numbered to 116. Hence, the prevalence of refractive error in pediatric population is 7.74%.

The mean age of presentation was 11.45±3.62 years, range (3-15 years). There was more female presentation. Female subjects comprised 51.7% (N=60) and 48.30% (N=56) were male participants.

Refractive error was most prevalent in 12-14 years of age group (31.03%) whereas it was least in 3-5 years age group (7.76%). Distribution of refractive error is shown in table 1. Most common refractive error found was Astigmatism in 45.26% (N=105 eyes) followed by Myopia (42.67%, N=99 eyes) and hypermetropia (11.21%, N=26 eyes). 2 eyes were emmetropic. Distribution of astigmatism showed compound myopic astigmatism as the most prevailed one with 60% prevalence (N=63 eyes), followed by simple myopic astigmatism (21.90%, N=23 eyes), compound hypermetropic astigmatism (8.57%, N=9 eyes), mixed astigmatism (3.8%, N=4 eyes), simple hypermetropic astigmatism (2.86%, N=3 eyes) and oblique astigmatism (2.86%, N=3 eyes).

Table 1. Distribution of refractive error

Refractive error	Frequency (No. of eyes)	Percentage (%)
Simple Myopia	99	42.67
Simple Hypermetropia	26	11.21
Astigmatism	**105**	**45.26**
Compound myopic	63	60
Simple myopic	23	21.90
Compound hypermetropic	9	8.57
Mixed	4	3.81
Simple hypermetropic	3	2.86
Oblique	3	2.86
Emmetropic	2	0.86
Total	**232**	**100**

It was striking to find very low number of pediatric patients using spectacle at the time of presentation. Prevalence of spectacle wear was not satisfactory as only 36.20% (N=42) pediatric population were using spectacle and rest 63.8% (N=74) didn't use spectacle prior to the examination.

Spectacle use history being unsatisfactory, suggests most of the children were having reduced vision and hence were having some form of visual impairment (Table 2). 43 children (37.1%) were grouped as having normal vision. These children might have refractive error in one eye or had

Table 2. Distribution of Visual Impairment

	Frequency	Percentage (%)
Normal Vision	43	37.1
Mild Visual Impairment	27	23.3
Moderate Visual Impairment	13	11.2
Severe Visual Impairment	25	21.6
Profound Visual Impairment	7	6.0
Near Total Visual Impairment	1	0.9
Total	116	100

error of low magnitude. 23.3% of children (N=27) had mild visual impairment followed by severe visual impairment in 25 children (21.6%), moderate visual impairment in 13 children (11.2%), profound visual impairment in 7 children (6.0%) and near total visual impairment in 1 child (0.9%).

Astigmatism was the most common refractive error succeeding myopia and hypermetropia. There were 105 astigmatic eyes (56 Right and 49 Left eyes). Against the rule astigmatism was the most common type found in 52 eyes (49.52%) followed by with the rule astigmatism in 50 eyes (47.62%). There were scanty cases of oblique astigmatism in only 3 eyes (2.86%).

There were 125 eyes with myopia and hyperopia. There was total 99 myopic eyes and 26 Hyperopic eyes.

Low degree of Myopia was the most prevailing one in 73 eyes (73.73% of total myopic eyes), followed by moderate myopia in 23 eyes (23.23% of total myopic eyes) and high myopia in 3 eyes (3.03% of total myopic eyes). Among hyperopes, low hyperopia was the most prevailed in 18 eyes (69.23% of total hyperopic eyes), followed by moderate and high hyperopia each with 4 eyes (15.38% of total hyperopic eyes).

Management of refractive error is very easy and economical. Mere spectacle wear can improve vision. After refractive correction, there were drastic changes in Visual impairment table. After refractive correction, 91.40% of the total cases i.e. 106 cases were grouped under normal vision. Only 6 cases (5.2%) had mild visual impairment, 3 cases (2.6%) had moderate visual impairment, and 1 case (0.9%) had severe visual impairment.

There was great improvement in visual acuity after refractive correction and hence many children had normal vision after correction. Number of children with visual impairment reduced to great extent after refractive correction.

Improvement in visual acuity after refractive correction (shown in Table 3). The mean presenting VA in RE was 0.55±0.46 log MAR and in LE was 0.54±0.43 log MAR (range, 0.00 log MAR -1.60 log MAR).

The mean best corrected VA in RE was 0.056±0.18 log MAR (range, 0.00 log MAR-1.20 log MAR) and in LE was 0.043±0.14 log MAR (range, 0.00 log mAR-1.00 log MAR).

Table 3. Presenting visual acuity and best corrected visual acuity

	Mean ±SD
PVA OD	0.55±0.46
VA after correction OD	0.056±0.18
PVA OS	0.54±0.43
VA after correction OS	0.043±0.14

Those cases that were not improved to normal visual acuity level (having visual impairment) were cases of amblyopia. On using paired sample t test between the two variables, presenting visual acuity and visual acuity after correction, the best corrected visual acuity differs significantly from presenting visual acuity for both right and left eye. Presenting Visual acuity was positively correlated with visual acuity after correction which was statistically significant (Table 4).

Table 4. Paired t test among presenting visual acuity and visual acuity after correction for right and left eye

Pair	Correlation, (r)	t test (t)	Mean difference	p value	95% CI
PVA OD – VA after correction OD	0.349	12.276	0.15	< 0.001	0.12-0.18
PVA OS – VA after correction OS	0.239	12.741	0.12	< 0.001	0.09-0.15

Significant at $p < 0.05$; highly significant at $p < 0.001$

DISCUSSIONS

Visual Impairment secondary to uncorrected refractive error can have severe and long-term consequences in children more than in adults, such as loss of educational and employment opportunities, hindrances in economic growth for individuals, families, and societies and impaired or degraded quality of life. Various factors contribute for refractive errors remaining uncorrected: lack of awareness and recognition of the problem at personal and family level; non-availability and/or inability to afford refractive services; insufficient provision of affordable corrective lenses; and cultural disincentives to compliance (WHO, 2003). The prevalence of refractive error and visual impairment secondary to the uncorrected refractive error is of public health concern despite its easy workout and that spectacle correction is among the most cost-effective interventions in eye care.

In this study, the prevalence of refractive errors among one thousand four hundred and ninety-eight (1,498) children, between 3-15 years old age in Dhulikhel, was found to be 7.74% which is less than the studies of Nepal et al. (8.1% in 5-17 years age groups) and Waadani et al. (prevalence of

refractive error among the primary school children in Saudi Arabia was 13.7%).[6,11] In another study, out of 5067 children from 5-15 years of age in Mechi, only 2.9% of children suffered from the refractive errors and similar study done by Shrestha et al. also had lower refractive error prevalence than our present study (7.49% in 5-16 years of age group children in Kathmandu valley).[5,12] Study done by Niroula et al. in Pokhara, showed 6.43% prevalence of refractive error.[13] Such wide variations of percentage in distribution of refractive errors concluded in different studies might be due to sample size, different geographical situation, ethnic variation, nutritional status, and different criteria adopted. Prevalence of refractive error was more among those aged 12-14 years (31.03%) in this present study which is like the study done by Waadani et al. in Saudi Arabia which also showed more refractive error prevailed in age group 12-14 years (47.5%).[11] Myopia and astigmatism are found to be more common in this age group. Hence, we can conclude that refractive error development has direct correlation with developing age of children.[13] During the growing period (10-19 years age), the children are subjected to various stresses and strains on eyes: near vision for reading and writing, watching Television and Computers use for more hours etc. Such strains are likely to develop myopia.[14] Correlation between near work and myopia had been observed by Saw et al. in Singapore, Mutti et al. in Orinda and Wong et al. in Hong Kong.[15-17]

In our study, refractive error was most prevalent in 12-14 years of age group (31.03%) whereas it was least in 3-5 years age group (7.76%). In a study performed by Pokharel A, older children in the age group of 12-15 years had the highest prevalence of refractive error (59.8%) and most of them (42.5%) had myopia. Nepal et al. reported that myopia and myopic astigmatism were not found in children below 7 years of age however it started increasing steadily in older children.[5] The prevalence of myopia was 4.5% in 8-10 years of age group which increased to 31.5% in 14-16 years of age but hypermetropia did not show such an increase.

Astigmatism was the commonest type of refractive error in our study (45.26%), followed by simple myopia (42.67%) which is like the study done by Rai et al. (astigmatism prevalence of 47% followed by myopia in 34%).[18] Most common type of astigmatism was compound myopic astigmatism followed by simple myopic astigmatism. This result of ours is also like that found by Rai et al. in their study.[18] However, in a study performed among rural and urban settings in Nepal, myopia was the commonest refractive error of prevalence 59.8%, followed by hyperopia 31.0%. This was like the results of the study by Nepal et al. but the prevalence rate was lower, prevalence of myopia being 52.8% and hyperopia being 15.73%.[5] The prevalence of myopia was 46.15% and hyperopia was 53.84% in a study by Pokharel et al. which contrasted with other studies where myopia is commonest.[6]

In our study, after refractive correction, 91.40% of the total cases achieved normal vision. There were no any cases of profound and near total visual impairment after refractive correction. Only 36.2% of the cases with refractive error had the history of spectacle use. In a study by Pokharel et al. in Nepal, even lesser population i.e., only 21% of the cases with refractive error used spectacles, 13.4% in rural Mongolia et al. and 30.3% in Taiwan.[19-21] Another study done by Kaiti et al. in adult population in Nepal also showed similar statistics of spectacle wear 40.50%.[22]

The 62.9% of total cases (N=73) had visual impairment; ranging from mild visual impairment to near total visual impairment due to uncorrected refractive error during presentation. The result found in the study done by Rai et al. showed only 7% children with visual impairment due to uncorrected refractive errors.[18] Mere refractive correction can improve visual acuity to normal level and help the children live independent life. In our study also, refractive correction improves visual acuity in many children and only 8.6% of the total cases (N=10) were left with some form of visual impairment even after refractive correction. These cases with visual impairment eve after refractive correction had refractive amblyopia in both eyes. Amblyopia was isoametropic type as in unilateral amblyopia only one eye has reduced vision and hence doesn't make the child visually impaired. All other forms like strabismus and stimulus deprivation cases were excluded from the study.

Hyperopia or astigmatism is present at birth or at early age. This might be the reason why it is presumed that these conditions are hereditary in nature.[18] On the other hand, since myopia is seldom present at birth but becomes significant and evident in late childhood, many researchers believe that it occurs as a result of environmental rather than hereditary factors.[18]

The barriers to spectacle use include factors such as parental unawareness of the vision problem, attitudes regarding the need for spectacles, high cost and the concern that wearing spectacles may cause progression of refractive error. Many parental and familial factors play role in reduced and ineffective spectacle use in children. Many parents have economical problem as a reason for not correcting their children with refractive error. Many have social stigma of wearing spectacle. They think refractive correction will make their children dependent on spectacle and will increase the error.

CONCLUSION

Pediatric vision directly affect their academic performance and social development. Lack of awareness, infrequent ocular examination and lack of community or preschool vision screening were the main causes for the late presentation and significant visual impairment associated with the condition. The high prevalence observed

necessitates urgent action, emphasizing the critical need for effective, regular, and accessible vision screening programs within school health initiatives.

ACKNOWLEDGEMENTS

We would like to extend our sincere gratitude to Mr. Seth Wolphin, Mrs. Janet Peterson and all respected members of WOV for their continuous support and inspiration throughout this project. We are also highly obliged to the Research Department of Kathmandu University Teaching Hospital for providing us with the opportunity to embark on this project. Additionally, we are thankful to all the staffs working in Ophthalmology Department of Dhulikhel Hospital for their support and invaluable help.

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