Prevalence of Refractive Error and Ocular Pathologies among School Children: Finding from the School Eye Program of Dhulikhel Hospital

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ABSTRACT

Background

Childhood blindness and visual impairments could lead to the onset of blindness among children and adolescents. New cases appear particularly between the ages of 6-15 years and if uncorrected, runs a risk of developing Amblyopia, strabismus. There exists a mounting need to strengthen and modify established school eye health programs in Nepal as per the local needs and conditions.

Objective

To determine the prevalence of refractive error and ocular pathologies among school children in rural Nepal.

Method

This cross-sectional study was conducted in nine schools of Kavrepalanchowk and Bhaktapur district with 953 students screened from December 2018 to February 2020. The team of optometrist, ophthalmic assistants and ophthalmologist applied a standard protocol for screening of refractive error as a part of the school eye program of Dhulikhel Hospital. Other standard eye examinations were performed to note the ocular pathologies. The association of socio-demographic factors of students having refractive errors with that in emmetropes was identified using logistic regression analysis.

Result

A total of 953 students were screened in nine study sites, age ranged from 5-19 years. There were 183 students (19.2%) with refractive errors. Blurred vision was the common complaint reported by 2.5% of students. Multivariate logistic regression analysis showed higher age group children (aOR=2.93; 95% CI: 1.62-5.29; P=0.01) and urban area children (aOR=4.37; 95% CI: 0.87-21.98; P=0.07) to have higher odds of refractive error.

Conclusion

Refractive error is the major eye problem among school children. Despite its high prevalence, there is still a major gap in timely diagnosis and treatment. Regular vision screening and timely treatment is required for better addressing refractive error among school-going children.

KEY WORDS

Ocular pathology, Refractive error, School children

INTRODUCTION

Globally, refractive error is the most common cause of visual impairment and the second leading cause of treatable blindness.[1] Visual impairment as the result of uncorrected refractive errors accounted for 153 million people over 5 years, of which 8 million are blind. Approximately, 12.8 million children of age group 5-15 years are visually impaired from uncorrected or inadequately corrected refractive errors, estimating a global prevalence of 0.96%.[2] Meanwhile, screening for ocular pathologies including refractive errors in schoolchildren is routinely done in developed countries.[3,4] However, there are no national school eye screening programs in many developing countries and refractive error is the fourth cause of blindness there.[5] Therefore, little is known about the prevalence of refractive errors and ocular pathologies among school children in developing countries including Nepal.[6]

According to the National Blindness Survey of Nepal of 1981, refractive error was identified as a primary ocular disorder in 1.3% of the 39,887 examined persons of all ages. They reported few cases of childhood blindness where the main causes were ocular infections, xerophthalmia, and congenital cataract.[7] The "Refractive Error Study in Children (RESC)" group conducted a study and reported refractive error was the major cause of visual acuity of 0.5 (20/40) or worse in at least one eye in 56% in Nepal. The study further reported that reduced vision, because of myopia, was an important public health problem in school children; and more than 9% of children could benefit from prescription glasses.[8] Similarly, the Nepal Xerophthalmia Survey, also conducted in 1981, showed 1.65% of children below 14 years had Bitot's spot.[9] We conducted this study in order to determine the prevalence of refractive error and ocular pathology among students.

METHODS

We conducted a cross-sectional study in 9 schools of Dhulikhel, Dapcha, Bolde and Bhaktapur communities of Kavrepalanchowk and Bhaktapur districts of Nepal. The sites and school were selected by convenient sampling. Dhulikhel Hospital is involved in conduction of multiple medical camps on all these school. All the school-going, 5 to 19 years of age belonging to pre-primary, primary, lower secondary and secondary grades were included in this study. We screened and examined 953 students between the period of December 2018 and February 2020.

The ocular examination was performed by a clinical team consisting of an ophthalmologist, an optometrist and an ophthalmic assistant. These examinations included visual acuity (VA) measurement, cycloplegic refraction, ocular motility evaluation, subjective refraction, examination of the external eye, anterior segment and fundus. We measured visual acuity using Snellen's illiterate "E" chart at 6 m distance. Subjective refraction was performed on children with uncorrected VA ≤ 6/12 in either eye. The cycloplegic refraction were performed with 1) all the children up to 7 years of age, eyes with hypermetropia and myopia of 6 D and more, (2) if retinoscopy findings and subjective refraction findings were not consistent with each other and (3) children with best corrected visual acuity (BCVA < 6/9) after dynamic refraction.

We diagnosed myopia if it was more than −0.5 D, hypermetropia if more than +1.0 D after cycloplegic refraction, and astigmatism if it was more than 0.5 D. An examination of the lens, vitreous and fundus was performed by the ophthalmologist, after cycloplegic dilation with a direct ophthalmoscope (Heine, Germany).

The study team underwent training to conduct the school eye program, and a pretesting was arranged in a separate school for familiarization and modification of the study protocol, equipment use, and measurement methods, questionnaires and data entry. The data including personal profile visual and ocular status and visual aid given was collected in the pre-tested form. An additional ophthalmologist participated in quality assurance, and an additional ophthalmic assistant administered the refractive errors risk factors questionnaire. The standard "Refractive Error Study in Children" protocol and data collection instruments were used to collect data including required information.[10-13] The ethical approval was obtained from the Kathmandu University School of Medical Sciences, Institutional Review Committee in Dhulikhel.

The accuracy and completeness of data forms were reviewed in the field before computer data entry into Microsoft Excel database (Microsoft Corporation, Redmond, WA, USA). Data entries were validated by a range of checks into the variables and rechecked for an outlier for possible data entry error. The VA was categorized into normal/near normal (VA ≥ 6/9), low vision (VA ≤ 6/12 to >3/60) and blind (VA < 3/60).[14] The prevalence of VI was calculated on the basis of uncorrected VA and presenting VA of 6/12 or worse in one or both eyes. The prevalence of VI due to refractive error was calculated based on uncorrected VA of 6/12 or worse in one or both eyes. Then myopia was defined as the spherical equivalent of at least -0.50 D and hyperopia as +2.00 D or more. The children were considered as myopic if one or both eyes were myopic, and hyperopic if one or both eyes were hyperopic, as long as neither eye was myopic. Vision impaired children due to astigmatism (-0.75 D or more) but had emmetropia when spherical equivalent conversion was considered were identified as emmetropic with astigmatism.

Statistical analyses were performed using STATA version 14.0 (StataCorp, College Station, TX, USA). Frequency distributions and point prevalence estimates of the visual outcomes are reported. The variance and associated 95% confidence intervals (CI) were estimated based on a multistage cluster design sample, with individual schools

defined as the primary sampling unit. The association of socio-demographic factors such as age, sex, grade level and locality (Bolde, Dapcha, Dhulikhel or Bhaktapur) with myopic VI compared with emmetropes was explored with logistic regression with robust standard error.

RESULTS

A total of 953 children were examined from nine schools of Bhaktapur and Kavrepalanchok districts between December 2018 and February 2020. Distribution of age, sex and visual impairments with school specific information of the examined children are shown in table 1. We found 1 (0.1%) child with ptosis, 2 (0.2%) with squint, 3 (0.3%) with dry eye, and 183 (19.2%) with refractive error.

Chief Complaints

The details of the chief complaints of surveyed children in the five study sites are presented in table 2. A total of 23 (2.5%) children reported blurred vision. Some students (0.4%) reported suffering from headache followed by 0.3% with burning sensation, 0.2% with red eyes and 0.3% with watering or discharge. None of the children reported of any history of systemic diseases or use of any drugs.

Visual Acuity (VA)

The details of visual acuity of the surveyed children are presented in table 3. A total of 814 children (85.5%) presented with normal or near-normal vision with distance (≥ 6/9.5) in the right eye and 801 (84.1%) with normal or near-normal vision with distance (≥ 6/9.5) in the left eye. A total of 116 (14.5%) and 151 (15.9%) children had uncorrected visual acuity of ≤ 6/12 in right and left eyes respectively. Similarly, 877 (92.2%) and 873 (91.7%) of the children had normal right and left eyes respectively. None of the children with lower vision were using spectacles or attending special schools. We found that with best-corrected visual acuity, no one had blindness. Prevalence of visual impairment due to myopia, hyperopia and emmetropia with astigmat

ism was 3.0%, 2.3% and 2.5% respectively in the right eye. The prevalence of visual impairments due to refractive errors showed a high prevalence (49.3%) into the age group 11-15 years. The refractive errors are higher in males (53.6%) compared to females (46.5%). The refractive error was higher in urban schools (50.8%) compared to semi-urban (24.0%) and rural schools (0.4%).

A total of 183 children who needed refractive corrections in one or both eyes, were given spectacles. Two children (0.2%) were referred to the central hospital for further investigations. Need of spectacles was higher among males and children of 11-15 years. None of the children in any locality (urban, semi-urban or rural) with refractive error had any corrections.

Multivariate logistic regression analysis for refractive error with age, sex and school

The multivariate logistic regression analysis (Table 4) showed that the higher age group children (≥ 16 years) had higher odds of refractive error (aOR=2.93; 95% CI: 1.62-5.29; P=0.01) compared to their counterparts (aOR=1.41; 95% CI: 0.92-2.18, P=0.12). Although not statistically significant, children from urban areas (school 4) appeared to have higher odds of refractive error (aOR=4.37; 95% CI: 0.87-21.98; P=0.07) compared to the children from semi-urban and rural areas (other schools except school 4).

Table 1. Prevalence of visual impairments among surveyed schoolchildrens according to according to age, sex and study schools

Category	Total no of screened (n(%))	Ptosis (n=1 (0.1%))	Squint (n=2 (0.2%))	Dry eye (n=3 (0.3%))	Refractive error (n=183 (19.2%))	Referral (n=2 (0.2%))	Normal (n=761 (80.0%)	Chi square value	P value
Age in years									
≤ 10 years	356 (37.4)	0(0.0)	0(0.0)	0(0.0)	57(31.1)	0(0.0)	299 (39.3)	60.4	0.001
11-15 years	467 (49.1)	0(0.0)	1 (50.0)	1 (33.3)	90 (49.2)	0(0.0)	375 (49.3)		
≥ 16 years	129 (13.5)	1 (100.0)	1 (50.0)	2 (66.7)	36 (19.7)	2 (100)	87 (11.4)		
Sex									
Male	465 (48.8)	0(0.0)	2(100.0)	0(0.0)	98 (53.6)	0(0.0)	365 (48.0)	8.94	0.18
Female	487(51.2)	1 (100.0)	0(0.0)	3 (100.0)	85 (46.5)	2 (100.0)	396 (52.0)		
School									
School 1 (Semi-urban/Rural)	16(1.7)	0(0.0)	0(0.0)	0(0.0)	11 (6.0)	0(0.0)	5 (0.7)	267.8	0.001
School 2 (Semi-urban/Rural)	563(59.1)	0(0.0)	1(50.0)	0(0.0)	93 (50.8)	0(0.0)	469 (61.6)		
School 3 (Semi-urban/Rural)	128(13.4)	1(100.0)	1(50.0)	3 (100.0)	6 (3.3)	2 (100.0)	115 (15.1)		
School 4 (Urban)	47(4.9)	0(0.0)	0(0.0)	0(0.0)	44 (24.0)	0(0.0)	3 (0.4)		
School 5 (Semi-urban/Rural)	20(2.1)	0(0.0)	0(0.0)	0(0.0)	2(1.1)	0(0.0)	18 (2.4)		
School 6 (Semi-urban/Rural)	6(0.6)	0(0.0)	0(0.0)	0(0.0)	3 (1.6)	0(0.0)	3 (0.4)		
School 7 (Semi-urban/Rural)	77(8.1)	0(0.0)	0(0.0)	0(0.0)	8(4.4)	0(0.0)	69 (9.1)		
School 8 (Semi-urban/Rural)	68(7.1)	0(0.0)	0(0.0)	0(0.0)	9 (4.9)	0(0.0)	59 (7.7)		
School 9 (Semi-urban/Rural)	27(2.8)	0(0.0)	0(0.0)	0(0.0)	7 (3.8)	0(0.0)	20 (2.6)		

Table 2. Prevalence of occular morbidities among surveyed schoolchildren in five study sites of Kavre and Bhaktapur Districts

Chief Complaints	Category	Frequency of screened	Percentage (%)
Blurred vision	Right eye	1	0.1
	Left eye	6	0.6
	Both eye	17	1.8
	No blurred vision	928	97.5
Duration of blurred vision	≤12 months	5	25.0
	12-24 months	8	40.0
	≥ 23 months	7	35.0
Headache	Present	4	0.4
	Absent	948	99.6
Burning sensation	Right eye	0	0
	Left eye	0	0
	Both eye	3	0.3
	No burning sensation	949	99.7
Redness	Right eye	0	0
	Left eye	0	0
	Both eye	2	0.2
	No redness	950	99.8
Watering/ Discharge	Right eye	0	0
	Left eye	2	0.2
	Both eye	1	0.1
	No discharge	949	99.7
History of systemic diseases	Yes	0	0
	No	100	100
History of use of any drugs	Yes	0	0
	No	100	100

Table 3. Details of visual acuity and prevalence of visual impairment among surveyed schoolchildren in five study sites of Kavre and Bhaktapur Districts

Visual Acuity and Refraction	Category	Frequency of screened children (n)	Percentage (%)
Right eye with distance	Normal	814	85.5
	Low vision	116	14.5
Left eye with distance	Normal	801	84.1
	Low vision	151	15.9
Right eye with PH	Normal	951	99.9
	Low vision	1	0.1
Left eye with PH	Normal	951	99.9
	Low vision	1	0.1
Right eye (WDR)	Myopia (-)	30	3.0
	Hypermyopia (+)	21	2.3
	Emmetropia with astigmatism (--/++)	23	2.5
	Normal	877	92.2
Left eye (WDR)	Myopia (-)	30	3.0
	Hypermyopia (+)	25	2.8
	Emmetropia with astigmatism (--/++)	24	2.5
	Normal	873	91.7
Right eye (sphere)	Myopia (-)	40	4.0
	Hyperopia (+)	8	0.8
	Plano	4	0.4
	Normal	900	94.5
Left eye (sphere)	Myopia (-)	43	4.4
	Hyperopia (+)	7	0.8
	Plano	4	0.5
	Normal	898	94.3
Right eye (cylinder)	Myopia (-)	16	1.7
	Hyperopia (+)	3	0.3
	Emmetropia with astigmatism (--/++)	0	0
	Normal	933	98.0
Left eye (cylinder)	Myopia (-)	18	2.0
	Hyperopia (+)	2	0.1
	Emmetropia with astigmatism (--/++)	0	0
	Normal	932	97.9
Right eye (axis)	Normal	934	98.1
	Uncorrected	18	1.9
Left eye (axis)	Normal	932	97.9
	Uncorrected	20	2.1

DISCUSSION

Our study aimed to assess the prevalence of visual impairments, refractive errors and ocular morbidities in school children aged between 5 to 19 years of age in the Kavre and Bhaktapur Districts of Nepal. The study showed that the visual impairments, refractive errors and ocular morbidities are common school health problems in Kavre and Bhaktapur Districts. The prevalence of presenting refractive error (19.2%) is higher than the study conducted in Jhapa and far western regions of Nepal.[15,16] Similar to the findings of our study, uncorrected refractive errors accounted for the major cause of visual impairments in the present study. This can partly be attributed to the larger age-range, with myopia increasing with age. Geographically, the location of the study is urban, semi-urban and rural where in urban areas, the exposure to gadgets as well as pollution might be higher leading to high prevalence of refractive error there. Another speculative reason may be attributed to the genetic influences from varying ethnicities.[15] Difference in ethnicities might have also been attributed to an exceptionally low prevalence of refractive error in younger aged children. The high burden of visual impairments due to uncorrected refractive error among surveyed school children in Kavre and Bhaktapur Districts suggests that regular refractive error screening

Table 4. Univarate and multivariate logistic regression for refractive error (one or both eyes) with age, sex and schools

Attribute	[n (%)]	Univariate analysis			Multivariate analysis		
		OR	95% CI	p-value	aOR	95% CI	p-value
Age							
≤ 10 years	356 (37.4)	1.00			1.00		
11-15 years	467 (49.1)	1.25	0.87-1.80	0.23	1.41	0.92-2.18	0.12
≥ 16 years	129 (13.5)	2.03	1.26-3.27	**0.01**	2.93	1.62-5.29	**0.01**
Sex							
Male	465 (48.8)	1.00					
Female	487(51.2)	0.79	0.57-1.09	0.16			
School							
School 1 (Semi-urban/Rural)	16(1.7)	1.00			1		
School 2 (Semi-urban/Rural)	563(59.1)	0.09	0.03-0.26	**0.01**	0.06	0.02-1.19	**0.01**
School 3 (Semi-urban/Rural)	128(13.4)	0.02	0.01-0.85	**0.01**	0.01	0.01-0.06	**0.01**
School 4 (Urban)	47(4.9)	6.67	1.38-32.25	**0.02**	4.37	0.87-21.98	**0.07**
School 5 (Semi-urban/Rural)	20(2.1)	0.05	0.01-0.31	**0.01**	0.04	0.01-0.26	**0.01**
School 6 (Semi-urban/Rural)	6(0.6)	0.45	0.01-0.19	0.42	0.41	0.06-2.78	0.36
School 7 (Semi-urban/Rural)	77(8.1)	0.05	0.02-0.25	**0.01**	0.04	0.01-0.16	**0.01**
School 8 (Semi-urban/Rural)	68(7.1)	0.07	0.04-0.62	**0.01**	0.06	0.02-0.22	**0.01**
School 9 (Semi-urban/Rural)	27(2.8)	0.16	0.76-6.33	**0.01**	0.14	0.03-0.54	**0.01**

and intervention should be an immediate action in schools.

Similar to the findings of other studies myopia is the main cause of visual impairment among the surveyed school children in our study.[8,15,17] However, visual impairment due to hyperopia was minimal (2.3%) in our sample population. The low prevalence of hyperopia could be attributed to the consequences of mild hyperopia and emmetropia present in the primary age, which is proportionately shifted to emmetropia and myopia respectively in secondary age.[18] We found age is a significant risk factor for refractive error and school locality (urban, semi-urban or rural) is the contributing factor. The association of age and school locality with refractive error could be attributed to children's high demand of higher calories with increasing age and low fulfillment, children involvement in more schooling hours, indoor activities such as watching television, using gadgets as they progress to higher grades and localities.

The prevalence of refractive error was slightly higher in males compared with females (53.6 vs. 46.5); however, its significance was lost (P=0.16) in the multivariate analysis. Our study is in line with the study conducted in Jhapa District of Nepal.[19] We hypothesized that males spent more time on activities associated with increased risk of developing refractive error such as indoor reading, playing gadgets, watching televisions, using mobile phones than females.

Similar to the previous studies findings our studies found urban schooling was significantly associated with refractive error.[8,20,21] The high prevalence of refractive error among children in urban schools may be attributed to the increased time spent on indoor activities compared to the children in semi-urban and rural areas. In addition, this variation in prevalence rates could be due to educational pressures, computer usages, lifestyle changes and nutritional status, which tend to be different in rural and urban environments.[22,23] However, we lack the data of indoor hours spent in different activities by the study children. Meanwhile, the present study findings suggest the need for school eye health awareness programs in the study sites that emphasize the importance of outdoor leisure activities among urban children. Further study is required to determine the details of hours spent on indoor activities and refractive error progression rate and its association with increased indoor time when children progress in higher ages.

Our study revealed that none of the vision impaired children had ever received any refractive correction or wear spectacles. This finding related to high unmet need for refractive correction has been documented in other studies.[1,8,11,21] Interestingly, in rural areas there is lack of access to eye units and optical shops. However, despite better access to eye units and optical shops in urban areas compared to those from rural areas, the children did not seek for or received any refractive error corrections. Health awareness regarding requirement of spectacles wear during visual impairments is therefore crucial along with regular vision screening including affordable optical dispensing focusing also in rural areas.[15]

Our study has some limitations. First, our study is a school-based sampling method that may have resulted in prevalence estimates not fully representative of the overall district population. Future studies need to consider the use of sample sizes specific to each age in relation to

age-specific prevalence of refractive error. Another major limitation in our study is that it did not include cycloplegic autorefraction on children with normal/subnormal vision (≥ 6/9.5), which restricted them from presenting the prevalence estimates of refractive error.

CONCLUSION

The refractive error is the most common cause of visual impairments in the rural, suburban and urban schools of Nepal. Most vision-impaired children in our study did not have spectacles, indicating that the need for treatment of refractive error is significant. With rapid urbanization in Nepal, the incidence of refractive error might be expected to increase in coming years. Regular vision screening programs, appropriate referral with the provision of affordable spectacles also in rural areas, and health education on outdoor activities and spectacle compliance are important for addressing refractive error.

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