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Prevalence of Refractive Errors among Under Five Year Children Attending in a Tertiary Eye Care Center of Nepal

Hari Bahadur Thapa,[1] Kabindra Bajracharya,[1] Sirshendu Chaudhuri,[2] Varun Agiwal,[3] Katie Judson,[4] Ken Bassett,[5] Mahesh Kumar Dev,[6] Saraswati Khadka Thapa,[1] Hari Prasad Upadhyay[7]

[1]Department of Pediatric Ophthalmology, Lumbini Eye Institute and Research Center, [2]Indian Institute of Public Health, Hyderabad, India, [3]Department of Biostatistics, Indian Institute of Public Health, Hyderabad, India, [4]Seva Canada, [5]Seva Foundation, Canada, [6]School of Optometry & amp; Vision Science, Queensland University of Technology, Brisbane, Australia, [7]Department of Statistics, Birendra Multiple Campus, Bharatpur, Chitwan, Nepal.

ABSTRACT

Introduction

Refractive errors are common vision problems that occur when the shape of the eye does not properly bend or refract light to focus it on the retina. The objective of this research was to estimate the prevalence among children under-five years of age in Lumbini, Nepal.

Methods

A hospital-based observational study was conducted among children attending the Lumbini Eye Institute and Research Center. Participants were selected over three months using systematic random sampling. Ophthalmic examination with retinoscopy (dry and wet) was used to determine refractive errors. The proportion of children with spherical equivalent myopia ≤-0.50 diopter (D), SE hyperopia ≥+2.00 D and SE astigmatism >0.5 in both eyes were calculated. Prevalence of myopia, hyperopia and astigmatism was reported by age, gender and religion.

Results

Among 1,561 recruited children, the prevalence of refractive errors was 15.4% (n=240, 95% CI: 13.6% to 17.3%). The prevalence was significantly higher among older children (3 to 5 years) than the younger children (OR: 4.7; 95% CI: 1.7 to 13.1). Myopia was the most common condition (n=211, 13.5%, 95% CI: 11.9% to 15.3%). Myopia and astigmatism were significantly higher among children 3 to 5 years (22.1% and 5.56% respectively). Hyperopia prevalence was significantly higher among infants (3.3%).

Conclusions

The prevalence of refractive errors increased with age that was relatively high among infants and young children.

Keywords: children; prevalence; refractive errors.

Correspondence: Hari Bahadur Thapa, Department of Pediatric Ophthalmology, Lumbini Eye Institute and Research Center, Bhairahawa, Rupandehi, Nepal. Email: haribdr2005@gmail.com. Phone: +977-9847044927.

INTRODUCTION

Refractive errors are common vision problems that occur when the shape of the eye does not properly bend or refract light to focus it on the retina. The retina is the light-sensitive tissue at the back of the eye that converts light into electrical signals, which are then sent to the brain for processing. Refractive errors can cause blurred vision and can be corrected with prescription eyeglasses, contact lenses, or, in some cases, refractive surgery. Recent studies and the WHO reports indicate that refractive errors are the first cause of visual impairment and the second cause of visual loss worldwide, as 43% of visual impairments are attributed to refractive errors.[8] The Global burden of Disease study estimated that there were about 596 million people with distance vision impairment due to uncorrected refractive error in 2020.[9] Visual impairment, if left uncorrected, increases disease burden for children, their families and the healthcare system.[10,11] The Strabismus, Amblyopia and Refractive Error in Singaporean Children (STARS) study[12]Amblyopia and Refractive Error in Singaporean Children (STARS to determine the prevalence of refractive error types in Singaporean Chinese children aged 6 to 72 months showed that the prevalence of myopia, hyperopia, astigmatism, and anisometropia were 11.0%, 1.4%, 8.6%, and 0.6%, respectively. The prevalence of myopia and astigmatism in young Singaporean Chinese children were high, but that of hyperopia was low. Age effects were observed for each refractive error category, but differences between the sexes were not significant. Age-related variation in myopia prevalence may be influenced by ocular development, environment, and/or testability. In a study among pre-school children (3-6years) in eastern part of Nepal[13], refractive error was the most common cause of visual impairment which was seen in 14.7% of children. The overall prevalence of myopia, hyperopia, and astigmatism was 7.9%, 4.8%, and 2.1% respectively. The distribution of refractive errors is different in different countries. A high prevalence of myopia in East Asian countries is a common finding in most previous studies. [14]However, the data on refractive errors among Nepalese children are patchy[15–17] and need continuous hospital-based evidence to supplement the existing data. Such evidence will help identify Nepalese children's eye-care needs in the absence of a robust community-based surveillance system. Notably, most studies on childhood refractive errors have been conducted on school-going rather than preschool children. The preschool visual screening aims to identify children with possible visual problems early, ensuring appropriate, timely assessment and early intervention. As refractive errors influence normal visual development and can cause amblyopia in children, the early determination of refractive errors can help prevent amblyopia and maintain sharp, focused vision in children. In this background, an eye hospital-based study was conducted to determine the burden of refractive errors among under-five children in a tertiary eye care center of Lumbini province, Nepal. In The Multi-Ethnic Pediatric Eye Disease Study (MEPEDS)[18], prevalence of myopia was higher in African American (6.6%) compared to Hispanic children (3.7%; P<0.001) whereas Hispanics showed a higher prevalence of hyperopia than African American children (26.9% vs. 20.8% respectively, P<0.001). It showed ethnicity-related differences in both hyperopia and myopia prevalence in preschool children. There was no significant gender differences found in the prevalence of refractive error for either ethnic group. We conducted a study to determine the religion-related differences in refractive errors and refractive errors differences in gender among the children in our setting.

METHODS

A cross-sectional study was conducted among 1561 participants between 6 months to 5 years

children, who visited Paediatric Department of Lumbini Eye Institute and Research Centre (LEIRC from November, 2022 to January, 2023. This centre is a tertiary paediatric referral centre of Nepal. Ethical approval was taken from institutional review committee of Lumbini Eye Institute and Research Centre (LEIRC) (Ref No. 28/022/023). Informed and written consent was obtained from all the parents or legal representatives. Participants were divided into three groups based age: Infants (6 months to 1 year), Toddlers (>1 year to 3 years) and Pre-school (>3years to 5 years). Participants were divided into Hindu, Buddhism and Muslim based on religion. Systematic random sampling was used to select participants. Every alternate participant was selected from the children who attended outpatient department of the LEIRC. Considering the prior prevalence of refractive errors in preschool children as 14.7% [6,] sample size was estimated to be 1,205. The sample size was calculated using Cochran formula[8] (, Where, n= minimum required sample size, the Z= 1.96 at 95% Confidence Interval (CI), p= prevalence of refractive errors = 14.7%,[6] q= 1-p = 85.3%, e= margin of error = 2%. The minimum sample size is 1205. The data was collected by an experienced optometrist. Questionnaires were administrated through face-to-face interviews from parents or caregivers and clinical data was taken through clinical observation. Children who were born at or after 37 weeks of gestation, had a history of normal or uncomplicated Caesarean delivery and birth weight of ≥2500 grams were included in this study. Children who had any ocular problems, such as active ocular inflammation, cataract, glaucoma, disc anomaly, retinal diseases, and previous history of any eye surgery were excluded. The study followed the tenets of the Declaration of Helsinki. For Retinoscopy and determination of refractive error researcher used a streak retinoscope (Heine Beta 200) and a lens rack or handheld trial lenses for retinoscopy. A wet retinoscopy was performed in all the children. Refractive error was measured after cycloplegia using a single drop of proparacaine 0.5% followed by two drops of cyclopentolate (five minutes interval between installations of each cyclopentolate). Cyclopentolate concentration was determined by age; 1% for children one year of age or older & 0.5 % for children six months to 11 months of age. Streak retinoscopy was performed after 30 minutes following the instillation of the second drop of cyclopentolate. The fellow eye was occluded for children with strabismus while performing retinoscopy to prevent off-axis retinoscopy. Children whose parents/guardians refused cycloplegia were not included in the refractive error analysis. Retinoscopy were performed by two optometrists. Ophthalmoscopy was performed by two ophthalmologists. Anterior segment examination was undergone using a magnifying loupe, torch and slit lamp. Posterior segment was examined by direct ophthalmoscope after dilation. Validity and Reliability of the data: Inter-examiner reliability was evaluated in a subgroup of 25 subjects randomly selected from the sample. Each optometrist was masked as to the other's results. Refractive errors were recorded as spherical equivalent (SE), defined as the spherical power plus half of the negative cylinder in a dioptre (D) unit. Myopia was defined as SE of at least ≤-0.50 D; and hyperopia as SE refractive error of ≥+2.00 D. Astigmatism was defined as a cylindrical measurement (negative notations) of >0.50 D.[19]Anisometropia was a difference of at least 2.00 D between eyes in SE or cylinder. Refractive error was defined as SE ≥ +2.00 D or ≤−0.50 D. This definition was also used to determine refractive error groups, with refractive error having SE ≥ +2.00 D or ≤ −0.50 D and without refractive error having SE between +1.75 D to −0.25 D. [20] The data were analyzed in STATA version 14.2. Descriptive analysis was done in terms frequency, median and inter-quartile range (IQR) to analyze the distribution of the study variables. The prevalence of refractive

errors was expressed along with an appropriate 95% confidence interval (CI). A Mann-Whitney and Kruskal-Wallis test was applied on spherical equivalent value to find the difference between two groups and more than two groups respectively. Chi-square test was applied to determine the association between the variables. Risks were assessed by odds ratio (OR) with 95% CI. A p-value <0.05 was considered statistically significant.

RESULTS

This study was conducted among 1,561 participants. The mean±SD of age was 39.2±16.9 months. Among them 61(3.91%) were infants, 601 (38.50%) were toddlers and 899 (57.59%) were pre-school children. Majority were males 1,019(65.3%) and belonged to Hindu 1,253 (80.3%) religion (Table 1).

The median spherical equivalent (SE) of the recruited children was 0.5D (IQR, -0.25D to 1.0D) in the right eye and 0.25D (IQR, -0.25D to 0.875D) in the left eye. The median SE based on age, gender and religion was presented in (Figure 1) and (Figure 2).

There was no gender difference in SE (p-value-=0.740) but significant difference in SE based on the religion (p-value=0.010). The distribution was wider among the toddlers and pre-school children which was statistically significant(p-value=0.004).Theoverallprevalence of refractive errors among all participants was 15.4% (95% CI: 13.6% to 17.3%). The prevalence of refractive error was substantially higher among the pre-school children (OR: 4.7; 95% CI: 1.7 to 13.1) while toddler children was lower prevalence of refractive error (OR: 0.3; 95% CI: 0.1 to 1.0) than the infants. The prevalence of RE in boys was 15.8% and girls was 14.6% but risk was almost similar in both gender (OR: 1.0; 95% CI: 0.7 to 1.3). Hindu children's (16.4%) was a higher prevalence and higher change to develop the RE (OR: 1.3; 95% CI: 0.9 to 2.0) as compared to Muslim children's (11.4%) (Table 1)

Table 1. Distribution of refractive errors (n=1561).

Variable	Total number of children	In Right Eye		In Left Eye		In Either Eye	
		Number	P (95% CI)	Number	P (95% CI)	Number	P (95% CI)
Age							
0-1	61 (3.91)	3	4.92(1.03-13.71)	4	6.56(1.82-15.95)	4	6.56(1.82-15.95)
1-3	601 (38.50)	12	2.00(1.04-3.46)	6	1(0.37-2.16)	13	2.16(1.16-3.67)
3-5	899 (57.59)	174	19.35(16.82-22.09)	120	13.35(11.19-15.75)	223	24.81(22.01-27.76)
Gender							
Boy	1019 (65.28)	128	12.56(10.59-14.75)	83	8.15(6.54-10)	161	15.80(13.61-18.19)
Girl	542 (34.72)	61	11.25(8.72-14.22)	47	8.67(6.44-11.36)	79	14.58(11.71-17.83)
Religion							
Hindu	1253 (80.27)	158	12.61(10.80-14.58)	116	9.26(7.71-11)	205	16.36(14.35-18.53)
Muslim	308 (19.73)	31	10.06(6.94-13.98)	14	4.55(2.51-7.51)	35	11.36(8.04-15.45)
Over all			12.17 (10.59-13.90)		8.33 (7.00-9.81)		15.44 (13.68-17.33)

When analyzed in both the eyes, we noticed a significant correlation in the refractive error in the right and the left eye (r=0.87, p-value<0.001). The prevalence of myopia, hyperopia and astigmatism according to age, gender and religion were presented in (Table 2).

myopia was substantially higher among the pre-school group children (22.1%, 95% CI: 19.5% to 25.0%) than the younger age group (infants and toddlers). The overall prevalence of hyperopia (1.9%, 95% CI: 1.3% to 2.7%) and astigmatism (3.7%; 95% CI: 2.8% to 4.8%)

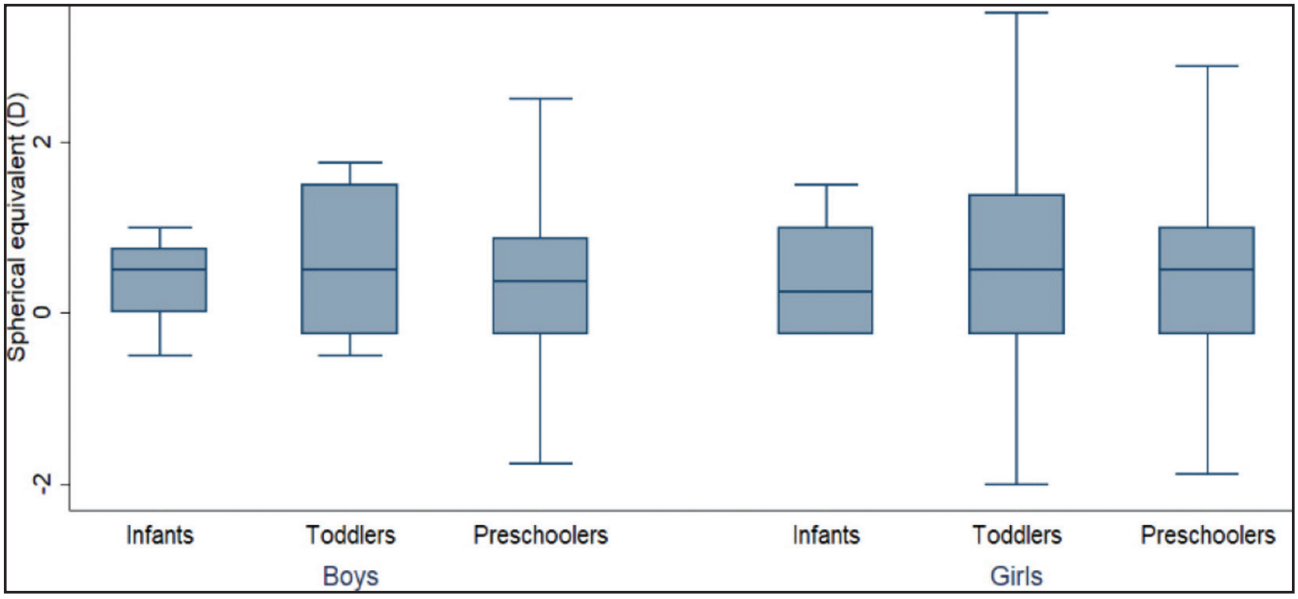

Figure 1. Distribution of spherical equivalent in different age groups and gender.

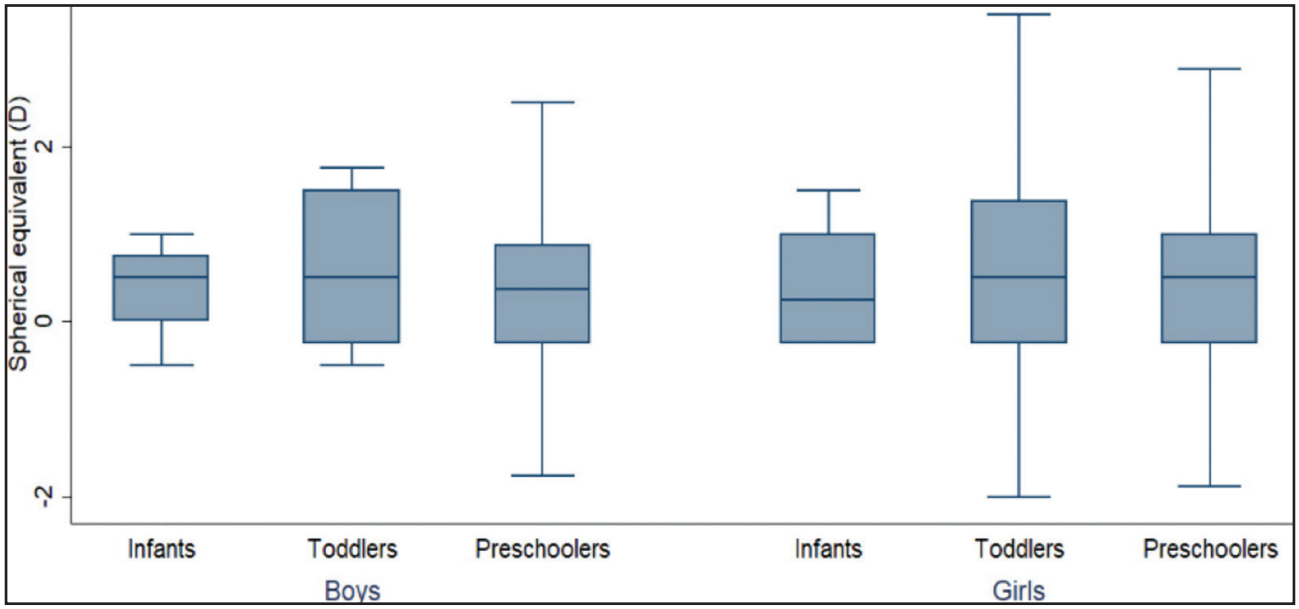

Figure 2. Distribution of spherical equivalent in different age groups and religion.

Myopia was the most common (13.5%, 95% CI: 11.9% to 15.3%) type of refractive error among all participants. The prevalence of

were comparatively less than myopia. While myopia and astigmatism were higher among the preschoolers, the prevalence of hyperopia was higher among the infants (3.3%, 95% CI:

Table 2. Prevalence of refractive errors in different age groups (n=1561).

Eye	Refractive error (D)	Overall	Age group		
			0-1	1-3	3-5
		n=1561,p (95% CI)	n=61, p (95% CI)	n=601,p (95% CI)	n=899,p (95% CI)
Right eye	Myopia	162,10.4(8.9-12.0)	1,1.6(0-8.8)	9,1.5(0.7-2.8)	152,16.9(14.5-19.5)
	Hyperopia	27,1.7(1.1-2.5)	2,3.3(0.4-11.4)	3,0.5(0.1-1.5)	22,2.5(1.5-3.7)
	Astigmatism	57, 3.7(2.8-4.7)	1,1.64(0.04-8.8)	7,1.16(0.47-2.38)	49,5.45(4.06-7.14)
	Emmetropia	565,36.2(33.8-38.6)	27,44.3(31.6-57.6)	240,39.9(36-44)	298,33.2(30.1-36.3)
Left eye	Myopia	106,6.8(5.6-8.2)	2,3.3(0.4-11.4)	3,0.5(0.1-1.5)	101,11.2(9.2-13.5)
	Hyperopia	24,1.5(1-2.3)	2,3.3(0.4-11.4)	3,0.5(0.1-1.5)	19,2.1(1.3-3.3)
	Astigmatism	49, 3.1(2.3-4.1)	1,1.64(0.04-8.8)	7,1.16(0.47-2.38)	41,4.56(3.29-6.14)
	Emmetropia	700,44.8(42.4-47.4)	30,49.2(36.1-62.3)	306,50.9(46.8-55)	364,40.5(37.3-43.8)
Either Eye	Myopia	211,13.5(11.9-15.3)	2,3.3(0.4-11.4)	10,1.8(0.9-3.3)	199,22.1(19.5-25)
	Hyperopia	29,1.9(1.3-2.7)	2,3.3(0.4-11.4)	3,0.5(0.1-1.5)	24,2.7(1.7-4)
	Astigmatism	58, 3.7 (2.8-4.8)	1,1.64(0.04-8.8)	7,1.16(0.47-2.38)	58,5.56(4.16-7.27)
	Emmetropia	840,53.8(51.3-56.3)	33,54.1(40.9-66.9)	340,56.6(52.5-60.6)	467,52(48.6-55.3)
	Anisometropia (abs(RE-LE)≥2.0)	8,0.5(0.2-1.0)	1,1.6(0-8.8)	2,0.3(0-1.2)	5,0.6(0.2-1.3)

Table 3. Prevalence of refractive errors in gender and religion (n=1561).

Eye	Refractive error (D)	Gender		Religion	
		Boys	Girls	Hindu	Muslim
		n=1019,p (95% CI)	N=542,p (95% CI)	n=1253,p (95% CI)	n=308,p (95% CI)
Right eye	Myopia	114,11.2(9.3-13.3)	48,8.9(6.6-11.6)	135,10.77(9.11-12.62)	27,8.77(5.86-12.5)
	Hyperopia	14,1.4(0.8-2.3)	13,2.4(1.3-4.1)	23,1.84(1.17-2.74)	4,1.3(0.35-3.29)
	Astigmatism	39,3.83(2.74-5.2)	18,3.32(1.98-5.2)	48,3.83(2.84-5.05)	9,2.92(1.34-5.47)
	Emmetropia	361,35.4(32.5-38.5)	204,37.6(33.5-41.9)	470,37.51(34.82-40.26)	96,31.17(26.04-36.67)
Left eye	Myopia	69,6.8(5.3-8.5)	37,6.8(4.9-9.3)	95,7.58(6.18-9.19)	11,3.57(1.8-6.3)
	Hyperopia	14,1.4(0.8-2.3)	10,1.9(0.9-3.4)	21,1.68(1.04-2.55)	3,0.97(0.2-2.82)
	Astigmatism	32,3.14(2.16-4.4)	17,3.14(1.84-4.97)	42,3.35(2.43-4.5)	7,2.27(0.92-4.63)
	Emmetropia	438,43(39.9-46.1)	262,48.3(44.1-52.6)	568,45.33(42.55-48.14)	132,42.86(37.26-48.59)
Either Eye	Myopia	145,14.3(12.2-16.6)	66,12.2(9.5-15.2)	180,14.37(12.47-16.43)	31,10.06(6.94-13.98)
	Hyperopia	16,1.6(0.9-2.5)	13,2.4(1.3-4.1)	25,2(1.3-2.93)	4,1.3(0.35-3.29)
	Astigmatism	39,3.83(2.74-5.2)	19,3.51(2.12-5.42)	49,3.91(2.91-5.14)	9,2.92(1.34-5.47)
	Emmetropia	540,53(49.9-56.1)	300,55.4(51.1-59.6)	686,54.75(51.94-57.53)	154,50(44.28-55.72)
	Anisometropia (abs(RE-LE)≥2.0)	5,0.5(0.2-1.1)	3,0.6(0.1-1.6)	7,0.56(0.22-1.15)	1,0.32(0.01-1.8)

0.4% to 11.4%). The burdens of all three forms of refractive errors were similar across the genders. The prevalence of myopia (14.4%, 95% CI:12.5 to 16.4), hyperopia (2.0%,95% CI: 1.3% to 2.9%) and astigmatism (3.9%, 95% CI: 2.9% to 5.1%) was higher among Hindu in comparison to Muslim.

Table 4. Compare of refractive error of gender and religion by age group (n=1561).

Eye	Variables	Age of Children Years)			P-value
		0-1	1-3	3-5	
Right eye	Gender				
	Boy	2(66.67)	6(50)	120(68.97)	0.397
	Girl	1(33.33)	6(50)	54(31.03)	
	Religion				
	Hindu	1(33.33)	10(83.33)	147(84.48)	0.06
	Muslim	2(66.67)	2(16.67)	27(15.52)	
Left eye	Gender				
	Boy	2(50)	2(33.33)	79(65.83)	0.228
	Girl	2(50)	4(66.67)	41(34.17)	
	Religion				
	Hindu	2(50)	5(83.33)	109(90.83)	0.031
	Muslim	2(50)	1(16.67)	11(9.17)	
Either Eye	Gender				
	Boy	2(50)	7(53.85)	152(68.16)	0.432
	Girl	2(50)	6(46.15)	71(31.84)	
	Religion				
	Hindu	2(50)	11(84.62)	192(86.1)	0.128
	Muslim	2(50)	2(15.38)	31(13.9)	

DISCUSSIONS

In this study, we determined the burden of refractive errors among children below five. We found that one out of eight children has myopia, and only two out of 100 children suffer from hyperopia. Notably, myopia's prevalence was substantially higher than the hyperopia. Most of the refractive errors were common among preschool children compared to the younger population. In this study, the prevalence of myopia was higher among children. This result is consistent with a large meta- analysis[19] with 606,155 children where the estimated pool prevalence (EPP) of myopia was 11.7%. The same study reported that the EPP of myopia in children ranged between 4.9% in South-East Asia and 18.2% in the Western Pacific region. Another systematic review with meta-analysis among Nepalese children[21] estimated that the pooled prevalence for myopia was 7.1% (95% CI: 3.7 to 11.4). In a study done in Singapore,[12] overall myopia (≤ −0.50 D) prevalence was 11.0%. However, population-based study from Asian and African settings has shown lower prevalence ranging from 1.3% to 3.7%.[20,22] Variations in prevalence could be either due to changes in setting or differences in definition and age group. The trend of myopia has increased linearly in the past three decades, maybe due to increased indoor activity due to computerization in recent years. The prevalence of hyperopia in our study was consistent with an earlier study done in Singapore.[12] The study estimated the

prevalence of hyperopia (SE≥+3.00D) to be 1.4%. With a definition of ≥ +2.00 for hyperopia, the prevalence shot up and ranged between 12.6% and 26.9%. However, pooled evidence from large meta-analysis suggests that the prevalence of hyperopia can be as low as 4.6% in children. The same study reports that the prevalence is even lower in South-East Asia (2.2%), but highest in the Americas (14.3%). Nevertheless, hospital- and school-based studies have shown a vast difference globally, ranging between 6.3% and 19.3%.[23,24] such prevalence should be interpreted cautiously as the definition of hyperopia was variable. Besides, hospital-based studies can show a high burden compared to community-based studies. In our study, astigmatism (SE>0.5) was the second most common refractive error among the children. The prevalence is substantially higher among preschool children (three-fourths) than in the younger age group. This result is similar to the STARS study[12] in which the prevalence increased with age for astigmatism (P<0.001) whereas in a study done by ArifahNurYahya et al.[20] majority of astigmatism was found within 6 to 11.9 months age group, and the prevalence decreased with age. As age increases, changes in lid pressure can produce changes in astigmatism. Prior studies in the same age group showed that nearly one out of four children has the condition.[20,24] On the contrary, a study conducted in Singapore[12] showed a prevalence of 8.6%, which is substantially lower than our finding. Astigmatism (≥ −1.50 DC) is this study population's most common type of refractive error. Pooled analyses from a meta-analysis[19] with 152,570 children showed the prevalence of astigmatism to be 14.9%. While the burden was lowest in South-East Asia (9.8%), it was highest in the Americas (27.2%) followed by the Eastern Mediterranean region (20.4%). For astigmatism, Asians and Hispanics had the highest prevalence[24] (33.6% and 36.9%, respectively) and did not differ from each other (p-value = 0.17). African Americans had the lowest prevalence of astigmatism (20.0%), followed by whites (26.4%). However, the study was in an older age group (5 to 17 years), and astigmatism's definition differed from ours.The burden of all three forms of refractive errors was similar across gender and religion. The result is similar to the STARS study[12] in which the age effects were observed for each refractive error category, but differences between the sexes were insignificant. A similar finding was observed in the study done by ArifahNurYahya et al.[20] where there was no significant association between the refractive error group (≥ +2.00 or ≥ −1.00 D) to race (p-value = 0.23) and gender (p-value = 0.88). However, the MEPEDS study[22] showed that the prevalence of myopia was higher in African Americans (6.6%) compared to Hispanic children (3.7%; p-value<0.001). Hispanics showed a higher prevalence of hyperopia than African American children (26.9% vs 20.8%, respectively, p-value<0.001). The prevalence of myopia showed a significant decreasing trend with age (p-value<0.001).Anisometropia was rare in our study (0.6%), which was similar to the studies of ArifahNurYahya et al.[20] (0.7%), Mayer et al.[25] (1%) and Dirani et al.[12] (0.55%). Although anisometropia is uncommon, it is crucial to detect anisometropia, because if left uncorrected through infancy, is likely to lead to the development of amblyopia.

CONCLUSIONS

Myopia a leading cause of vision impairment, was the most common prevalent among the preschool children in our setting. The prevalence could be even higher in the community which is largely undetected. So, it is important to detect amblyogenic refractive errors as early as possible, because if left uncorrected, may lead to development of amblyopia. Also, hospital-based opportunistic screening, and school-based screening can be enforced to identify and

manage the undetected refractive errors among children.

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Limitations: As the study is hospital-based, the estimate might be an overestimate of the actual population burden. However, considering the paucity of evidence in this age group, the evidence in our study can serve as a piece of baseline information.

Conflicts of Interest: None.

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