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REFRACTIVE ERRORS AND THEIR ASSOCIATION WITH OCULAR BIOMETRY IN RURAL CHILDREN OF CENTRAL INDIA

Ophthalmology

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ABSTRACT

Purpose: The objective was to assess prevalence of Refractive errors (RE) in children and correlation with ocular biometrics in rural population of central India.

Material and Methods: We examined 4295 children (below 18 years) of 3 rural schools in central India. A detailed history and ocular examination (Snellens visual acuity, wet retinoscopy, slit lamp and fundus examination) were done on 492 children with subnormal vision. The axial length (AL), anterior chamber depth (ACD) and keratometry (K) were measured using an IOL MASTER (CARL ZEISS Meditec AG 07740 Jena, Germany).

Result: We found 492 children/875 eyes (492/4295; 11.45%) with RE. They had a mean age of 11.6 ± 4.39 years (5-18yrs), with 48.57% males and almost two third (60.1%) were between 13-18 years of age. Myopia (68.91%) was most common RE followed by hypermetropia (14.86%) and astigmatism (16.23%). Mean spherical equivalent (SE) of study subjects was -1.71D (±4.68), mean AL was 23.35(±1.85) mm, mean ACD was 3.13(±0.57) mm and mean K values- 43.47(±2.05) D (horizontal) and 43.87(±2.15) D (vertical). AL & ACD showed strong negative correlation with RE in both myopia and hypermetropia(r=-0.697, -0.396 and -0.192, -0.510 respectively; p =<0.001).

Conclusion: The burden of RE is high in rural Indian children with no gender predilection. Myopia is most common childhood RE, and its incidence increases with age. The AL and ACD determine the SE, while corneal curvature does not. AL is predominant biometry measure determining SE. The role of K in determining SE is least for overall SE, myopia and hypermetropia.

KEYWORDS

Refractive error, ocular biometry, children, myopia, hypermetropia

INTRODUCTION

Refractive error (RE), the most common cause of ocular morbidity, is a complex multifactorial disease. About 19 million children below the age of 14 years are visually impaired, refractive errors being the principal cause.[1,2]

The axial length (AL), keratometry (K), central corneal thickness (CCT), anterior chamber depth (ACD) and lens thickness (LT) are the primary refractive components of the eye.[3-5] These components change with the age and are responsible for the variation of refraction. So according to some studies, part of RE has been attributed to ocular biometrics.[6].Despite numerous studies, only AL is considered the best association causing REs, and the association with other components have been less elaborated. The data on the magnitude, patterns of pediatric RE and their correlation with ocular biometry parameters is sparse in India (none correlating biometry).[7] This study examined the pattern of RE in rural school goin children in central India and its correlation with ocular biometric parameters.

METHODOLOGY

We examined 4295 children of 3 rural schools in central India. All children below 18 years were assessed using Snellen visual acuity chart, and those with subnormal vision/using spectacles were brought to the hospital for a detailed workup. 875 eyes of 492 children brought to ophthalmology department had refractive error. Children with other ocular diseases affecting vision and history of ocular surgery/trauma were excluded. An informed consent was taken from the parents of each child brought to the hospital. The study was approved by the instutional review board. A short history was recorded, and an ophthalmic examination including baseline visual acuity and retinoscopy under cycloplegia (eye ointment atropine 1% for 5-8 years children and eye drop homatropine 2% for 9-18 years children) was done. Atropine eye ointment was instilled 3 times a day for 3 days and eydrop homatropine was instilled 4 times every 10 minutes before doing retinoscopy. IOL MASTER (CARL ZEISS Meditec AG 07740 Jena, Germany) was used to record the AL in mm, ACD in mm, Keratometry-horizontal and vertical (KH, KV, respectively).

The refractive errors were classified according to spherical equivalent (SE) values[8].SE was defined as the sphere plus half negative cylinder. Myopia was defined as a SE of −0.5D or more (Low myopia −0.5 to −3.0D, Moderate myopia −3.25 to −6.0D, High myopia more than −6.0D) while Hypermetropia was defined as a SE of +0.5D or more (Mild +0.5 to +2.0D, Moderate- +2.25 to + 4.0D and High more than +4.0D).[8] Astigmatism is defined as an error of 1.0D or more.[8] Simple hypermetropic and myopic astigmatism was a cylindrical error of ±1.0D or more with no spherical error. Compound hypermetropic and myopic astigmatism was defined by a cylindrical error of ±1.0D or more with a spherical equivalent of ±0.5D or more.

Data were analysed using SPSS, version 22 software program. Independent Sample T Test and ANOVA test were used to compare means of groups. Relationship among factors was established with the Chi-square test and the correlation using pearson's correlation coefficients (level of significance p value < 0.05).

RESULTS

11.45 %(492/4295; CI:10.5-12.8) of the kids had RE in one or both the eyes. 875 eyes of 492 children with the mean age of 11.6 ± 4.39 years (Range 5-18yrs) were included for further analysis. 109 eyes were excluded (no refractive error/ocular pathology/trauma). 239 patients were male (48.57%) and 253 females (51.43%) (p value= 0.535). Almost two third of the children (n=296, 60.1%) were between 13-18 years of age. The remaining 75 children (15.24%) were between 5-8 years and 121(24.59%) between 9-12 years.

Myopia (n= 603eyes, 68.91%) was the most common RE followed by hypermetropia (n=130, 14.86%) and astigmatism (n=142, 16.23%).(Table 1) Overall, low myopia was the most common RE subtype (n=415, 47.42%). Low myopia and high hypermetropia were the most common subtype of myopia and hypermetropia respectively (p value <0.001 for both). Myopic astigmatism (n=119 eyes) was more common than hyperopic astigmatism (n=23 eyes) (p value<0.001) (Table 1). Of 142 eyes with astigmatism, 105(73.94%) eyes had cylindrical error between 1-2D and 37(26.06%) eyes had cylindrical error between 2.25-4D. Myopia was more prevalent in the older age group i.e. 13-18 years. (p value <0.001) (Table 2)

The mean SE of study subjects was -1.71D (±4.68D). The mean AL (23.81 mm)was more and anterior chamber(3.34 mm) deeper in myopic eyes than that of hypermetropic eyes(AL=21.33 mm & ACD=2.25 mm)(p value <0.001 for both).The cornea of myopic eyes was significantly steeper than hypermetropic eyes (p value 0.001 & 0.003 respectively).(Table3) Among myopic eyes, AL and ACD were significantly higher in the high myopia than moderate and low myopia (p value <0.001 for both).While among hypermetropic eyes, AL and ACD was significantly higher in the low hypermetropia than moderate and high hypermetropia (p value <0.001 for both) (Table 3).

SE correlated significantly with AL, ACD and keratometry (Table 4). When analysed separately for myopia and hypermetropia, there was a strong statistically significant negative correlation of SE with AL (P =<0.001) and ACD (P =<0.001). Thus, AL and ACD increase as myopia increases from low to high myopia and decreases as hypermetropia increase from low to high hypermetropia. (Table 4)

The mean cylindrical error was 1.76D (±0.79). The Average difference of hoizonal and vertical keratometry (2.36 ±0.97D) correlated with this cylindrical error in eyes with astigmatism(Pearson Correlation (r)= 0.430,p value<0.001).

DISCUSSION

The overall prevalence of RE in school childen was 11.45% (CI:10.5-12.8), similar to the published values in India.[9] There was no gender predilection (p =0.535),as is reported in majority of the studies.[10-16]

The REs were more common in older children between 13-18 years(p <0.001) and myopia was most prevalent, followed by hypermetropia and astigmatism.(p <0.001).The literature reports similar findings and trend in varied geographical locations.[4,10,12,16-20] The current studies report myopia to be the commonest refractive error, and gender, near work, lifestyle, ethnicity and many other factors are likely responsible.[21,22] The Kawuma M et al. however found astigmatism (52%) to be the commonest refractive error, while Falkenberg H K found hypermetropia to be the commonest.[23,24] The former had found refractive error in 73 out of 623(11.6%) school children.

The prevalence of childhood myopia increased with age (p<0.001) while that of hypermetropia and astigmatism decreased (p <0.001 and p <0.001 respectively), similar to finding of many other studies.[4,18,24-27]

The decrease in hypermetropia and astigmatism in older age groups is likely related to the process of emmetropisation. The younger participants having smaller eyes may explain the higher prevalence of hypermetropia and enlargement of eye with age may explain shifts towards myopia.[27] The CLEERE study also found Asian children showed the greatest association between more myopic/less hyperopic refractive error and age.[21]

In our study, the commonest subtype of refractive error was low myopia, accounting for almost half of all the eyes (47.42%).[18] Among hypermetropia, the largest number of eyes was of high hypermetropia. This is likely related to inclusion of a large number of children below 9 years of age (n=138, 28.04%).

There was a strong negative correlation of SE with AL (P =<0.001), ACD (P =<0.001) and keratometry (p value 0.003, <0.001). It means AL and ACD increases as myopia increases from low to high myopia and decreases as hypermetropia increase from low to high hypermetropia. The SE of myopic and hypermetropic patients correlated with AL and ACD, but not with keratometry when analysed separately. The literature shows clear correlation of axial length with the amount of refractive error, but the association with ACD is unclear.[8, 28-30] The strongest correlation with AL proves it to be the strongest biometry measure determining refraction and SE.[31]The role of K is determining SE is least for overall SE, myopia and hypermetropia.

Our study showed that corneal curvature was more in myopic eyes than hypermetropic eyes, although not statistically significant. Similar results were given by many studies.[8,32,33]

Thus, the refractive errors were more common in older children with no gender predilection. Myopia is most common childhood refractive error, and its prevalence increases with age. The AL and ACD correlate strongly with the SE, but almost no correlation was found with corneal curvature in myopia and hypermetropia. AL is the most predominant biometry measure determining the SE of refraction.

Table 1: Distribution of different types of refractive errors

Types of refractive errors	No. of eyes	Percentage (%)
Myopia	603	68.91
Low myopia	415	47.42
Moderate myopia	109	12.45
High myopia	79	9.02
Hypermetropia	130	14.86
Low hypermetropia	36	4.11
Moderate hypermetropia	20	2.22
High hypermetropia	74	8.45
Astigmatism	142	16.23

Table 2: Distribution of refractive errors in the three age groups

Type of refractive error	Age groups			P value
	5-8 years (%)	9-12 years (%)	13-18 years (%)	
Myopia (n=603eyes)	62(44.92%)	152(68.77%)	388(75.24%)	0.001
Hypermetropia (n=130eyes)	41(29.71%)	30(13.57%)	59(11.42%)	<0.001
Astigmatism (n=142eyes)	35(25.36%)	39(17.66%)	69(13.34%)	0.001
Total	138	221	516	

Table 3: Ocular biometry and spherical equivalent at different levels of myopia and hypermetropia

Types of refractive error	Spherical equivalent (D)	Axial length (mm)	ACD (mm)	K1(D)	K2 (D)
Myopia (N=603)	-2.93D (±3.83)	23.81 (±1.62)	3.34 (±0.34)	43.61 (±1.90)	43.93 (±2.02)
High myopia	-11.18 (±1.51)	26.49 (±1.51)	3.57 (±0.19)	44.13 (±2.61)	44.62 (±2.93)
Moderate myopia	-3.74 (±0.60)	24.30 (±0.99)	3.53 (±0.03)	43.06 (±1.96)	43.25 (±1.92)
Low myopia	-1.15 (±0.84)	23.17 (±1.13)	3.33 (±0.20)	43.69 (±1.68)	43.98 (±1.76)
Hypermetropia (N=130)	+3.10D (±2.16)	21.33 (±1.49)	2.25 (±0.27)	42.70 (±2.17)	43.25 (±1.94)
Low hypermetropia	+0.72 (±0.35)	22.30 (±1.80)	2.42 (±0.31)	44.13 (±2.16)	44.18 (±2.00)
Moderate hypermetropia	+3.14 (±0.40)	21.40 (±0.57)	2.28 (±0.21)	42.75 (±2.27)	43.41 (±2.15)
High hypermetropia	+6.06 (±1.43)	20.84 (±1.25)	1.99 (±0.10)	41.98 (±1.70)	42.75 (±1.69)
All eyes	-1.75 (±4.68D)	23.35 (±1.85)	3.13 (±0.57)	43.47 (±2.05)	43.87 (±2.15)

Table 4: Correlation of spherical equivalent with ocular biometry parameters

Mean refractive error(Spherical equivalent)	Ocular Biometry Parameter	Pearson Correlation (r)	P value (Significant 2-tailed)
Mean overall Spherical equivalent (N=875)	AL(mm)	-1.37	<0.001
	ACD	-0.120	0.001
	KH	-0.105	0.003
	KV	-0.588	<0.001
Myopia(N=603)	AL(mm)	-0.697	<0.001
	ACD	-0.192	<0.001
	KH	0.013	0.758
	KV	0.014	0.736
Hypermetropia (N=130)	AL(mm)	-0.396	<0.001
	ACD	-0.510	<0.001
	KH	-0.061	0.488
	KV	-0.032	0.715

Note-AL-Axial length, ACD-Anterior chamber depth, KH, KV-horizontal and vertical corneal keratometry

REFERENCES

1. Khurana AK, Khurana B. Comprehensive ophthalmology. Sixth edition.Jp publication,2015;42.
2. Resnikoff S, Pascolini D, Mariotti SP, Pokharel GP. Global magnitude of visual impairment caused by uncorrected refractive errors in 2004. Bull World Health Organ.

2008 Jan;86(1):63-70
3. Morgan IG, Rose KA, Ellwein LB. Refractive error study in children survey group. Is emmetropia the natural endpoint for human refractive development? An analysis of population-based data from the refractive error study in children (RESC) Acta Ophthalmol. 2010; 88:877–84.
4. Dandona R, Dandona L, Srinivas M, Sahare P, Narsaiah S, Muñoz SR, et al. Refractive error in children in a rural population in India. Invest Ophthalmol Vis Sci. 2002;43:615–22
5. Ip JM, Huynh SC, Robaei D, et al. Ethnic differences in refraction and ocular biometry in a population-based sample of 11-15-year old Australian children. Eye (Lond) 2008; 22(5):649-56.
6. Shufelt C, Fraser-Bell S, Ying-Lai M, et al. Refractive error, ocular biometry, and lens opalescence in an adult population: the Los Angeles Latino Eye Study. Invest Ophthalmol Vis Sci 2005; 46(12):4450-60.
7. Joseph S, Krishnan T, Ravindran RD, et al. Prevalence and risk factors for myopia and other refractive errors in an adult population in southern India. Ophthalmic Physiol Opt. 2018;38(3):346–358.
8. Ojaimi E, Rose KA,et al.Distribution of ocular biometric parameters and refraction in population-based study of Australian children. Invest Ophthalmol Vis Sci 2005;46:2748-2754.
9. Sheeladevi S, Seelam B, Nukella PB, Modi A, Ali R, Keay L. Prevalence of refractive errors in children in India: a systematic review. Clin Exp Optom. 2018;101(4):495-503.
10. Kedir J, Girma A. Prevalence of refractive error and visual impairment among rural school-age children of Goro District, Gurage Zone, Ethiopia. Ethiop J Health Sci. 2014;24(4):353–358.
11. O'Donnell C, Hartwig A, Radhakrishnan H. Correlations between refractive error and biometric parameters in human eyes using the LenStar 900. Cont Lens Anterior Eye. 2011;34(1):26–31.
12. Mehari ZA, Yimer AW. Prevalence of refractive errors among schoolchildren in rural central Ethiopia. Clin Exp Optom. 2013;96(1):65–69.
13. Saxena R, Vashist P, Tandon R, et al. Incidence and progression of myopia and associated factors in urban school children in Delhi: The North India Myopia Study (NIM Study). PLoS One. 2017;12(12):e0189774.
14. Murthy GV, Gupta SK, Ellwein LB, et al. Refractive error in children in an urban population in New Delhi. Invest Ophthalmol Vis Sci. 2002;43(3):623–631.
15. Wen G, Tarczy-Hornoch K, McKean-Cowdin R, et al. Prevalence of myopia, hyperopia, and astigmatism in non-Hispanic white and Asian children: multi-ethnic pediatric eye disease study. Ophthalmology. 2013;120(10):2109–2116.
16. Dirani M, Chan YH, Gazzard G, et al. Prevalence of refractive error in Singaporean Chinese children: the strabismus, amblyopia, and refractive error in young Singaporean Children (STARS) study. Invest Ophthalmol Vis Sci. 2010;51(3):1348–1355.
17. Dandona R, Dandona L. Refractive error blindness. Bull World Health Organ. 2001;79(3):237–243.
18. Jang JU, Park I. The status of refractive errors in elementary school children in South Jeolla Province, South Korea. Clin Optom (Auckl). 2015;7:45-51
19. Rezvan F, Khabazkhoob M, Fotouhi A, et al. Prevalence of refractive errors among school children in Northeastern Iran. Ophthalmic Physiol Opt. 2012;32(1):25–30.
20. Pokharel A, Pokharel PK, Das H, Adhikari S. The patterns of refractive errors among the school children of rural and urban settings in Nepal. Nepal J Ophthalmol. 2010;2(2):114–120.
21. Twelker JD, Mitchell GL, Messer DH, et al. Children's Ocular Components and Age, Gender, and Ethnicity. Optom Vis Sci. 2009;86(8):918–935.
22. Morgan I, Rose K. How genetic is school myopia? Prog Retin Eye Res. 2005;24:1–38.
23. Kawuma M, Mayeku R. A survey of the prevalence of refractive errors among children in lower primary schools in Kampala district. Afr Health Sci. 2002;2(2):69–72.
24. Falkenberg HK, Langaas T, Svarverud E. Vision status of children aged 7-15 years referred from school vision screening in Norway during 2003-2013: a retrospective study. BMC Ophthalmol. 2019;19(1):180.
25. Goh PP, Abqariyah Y, Pokharel GP, Ellwein LB. Refractive error and visual impairment in school-age children in Gombak District, Malaysia. Ophthalmology. 2005;112(4):678–685.
26. He M, Zeng J, Liu Y, Xu J, Pokharel GP, Ellwein LB. Refractive error and visual impairment in urban children in southern china. Invest Ophthalmol Vis Sci. 2004;45(3):793–799.
27. Grosvenor T. A review and a suggested classification system for myopia on the basis of age-related prevalence and age of onset. Am J Optom Physiol Opt. 1987;64(7):545–554.
28. Hashemi H, Fotouhi A, Mohammad K. The age- and gender-specific prevalences of refractive errors in Tehran: the Tehran Eye Study. Ophthalmic Epidemiol. 2004;11(3):213–225.
29. Llorente L, Barbero S, Cano D, Dorronsoro C, Marcos S. Myopic versus hyperopic eyes: axial length, corneal shape and optical aberrations. J Vis. 2004;4(4):288–298.
30. Strang NC, Schmid KL, Carney LG. Hyperopia is predominantly axial in nature. Curr Eye Res. 1998;17(4):380–383.
31. Chen MJ, Liu YT, Tsai CC, Chen YC, Chou CK, Lee SM. Relationship between central corneal thickness, refractive error, corneal curvature, anterior chamber depth and axial length. J Chin Med Assoc. 2009;72(3):133–137.
32. Touzeau O, Allouch C, Borderie V, Kopito R, Laroche L. Corrélation entre la réfraction et la biométrie oculaire [Correlation between refraction and ocular biometry]. J Fr Ophtalmol. 2003;26(4):355–363.
33. Dogan M, Elgin U, Sen E, Tekin K, Yilmazbas P. Comparison of anterior segment parameters and axial lengths of myopic, emmetropic, and hyperopic children. Int Ophthalmol. 2019;39(2):335–340.