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Original Research Article

Five-Year Demographic Profile, Prevalence, and Pattern of Refractive Errors in Age Group of 03-17 Years and Their Correlation with Axial Length of Eye Ball, at a Tertiary Care Institute in North India

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Abstract

Background: Refractive errors are main cause of visual impairment in children. Myopia especially is more prevalent in society. Untreated refractive errors may lead to other ocular disorders like squint and amblyopia.

Aim: The present retrospective hospital based clinical study was aimed at assessing the demographic profile, prevalence, and pattern of refractive errors in children of age group 03 to 17 years.

Methods: The study included 829 patients aged 3 to 17 years old with refractive errors, divided into only myopia (229 subjects), myopia along with astigmatism (465 subjects), only hypermetropia (30 subjects), and hypermetropia with astigmatism (105 subjects) who visited the Ophthalmology OPD during the span of last five years. Unaided visual acuity was recorded. Visual acuity with previous glasses was recorded for the patients who were already using spectacles. Cycloplegic refraction was done. Retinoscopy after dilating pupil with cycloplegic/ mydriatic drug was done. Thorough ocular examination, including retina examination after pupil dilatation to rule out any underlying retinal cause of diminution of vision was done. Final refraction was done and spectacles were prescribed. Best corrected visual acuity with glasses was recorded. State of isometropia or anisometropia was recorded. Axial length by optical bio meter was measured in undilated state of pupil.

Results: The refractive error cases were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years respectively, with a mean age of 7.8±3.21 years. In the myopia group, myopia with astigmatism group aged 03 to 05, the hyper myopia group 06 to 08 year, and in the hypermetropia with astigmatism group was 09 to 11 years of age. The axial length of the eyeball on the right eye was 22,66±1.51, in myopia cases were 5, 353, 279, 48, and 9 and left eye was 22.70±1.50, were 3, 349, 284, 50, and 8 cases, respectively.

Conclusion: The study findings revealed that, 06 to 08 age groups are more susceptible to Refractive Error. The most common refractive error in children was myopia then hypermetropia, which became more common as children aged. The more was axial length; degree of myopia was also high in such patients. While in case of hypermetropia, the eye ball was relatively shorter in length. Thus, the axial length was directly related to type of refractive error and is major predictor of progression of myopia.

Keywords: Amblyopia, Anisometropia, Astigmatism, Axial Length, Hypermetropia, Myopia.

Introduction

There is increasing trend of refractive errors, especially myopia in school going children. Children usually do not recognize that their visual acuity is less than normal unless they are screened properly. [1] Children are more affected by refractive errors. Children having subnormal vision usually shift themselves closer to the object of regard like sitting in front row in the schools or sitting close to their television at home. [2]

Now a day some schools have started rotational sitting arrangement in classes. Sitting position of children changes on daily basis. Children sitting in back seats are given special attention whether they are able to read the board as well as they could while sitting on the front seats. These students are instructed to get their eye checkup. Some schools have their own vision screening room. Sometimes a team of optometrist and ophthalmologist carry out screening camps in schools and nearby areas to screen children. But in majority of school this type of arrangement is not there. So, these children remain unscreened. A large majority of these children remain under diagnosed as most of them do not attend eye department. [3]

Uncorrected refractive errors, especially high degree refractive errors lead to other ocular disorders in children like state of amblyopia and squint. Uncorrected refractive errors may affect children directly or indirectly like poor performance in school due to difficulty in copying from black board while sitting on back benches in classroom, lack of interest in outdoor activities leading to other physical and socio-psychological problems in children. [4] These children try to remain inside home and they start overusing of mobile, computers, tablets, television and other electronic gazettes. This in turn again leads to deprivation from sun light, physical activities thus causing increase in refractive errors. Squint due to high refractive error, anisometropia or amblyopia can affect the social life of children. [5]

Children especially adolescent having squint may avoid social gathering and try to isolate themselves in classroom. Lack of awareness among parents, especially lower socio-economic group, infrequent ocular examination and lack of community or preschool vision screening programs in rural areas may be the main causes for the late presentation to Opthalmalogy OPD and persistent and significant visual impairment associated with the condition. Social stigma, economical limitation as well as negative counseling and attitudes about spectacle wear may further aggravate the situation leading to permanent visual impairment. More over workup for refractive error in pediatric patients is more cumbersome and tedious job, so many times those children do not get proper time and attention which is required for their examination. [6]

Axial length is measurement of total length of eye ball from anterior surface of cornea to retina. The axial length is directly related to extent of axial refractive error like axial myopia or hypermetropia. In case of axial myopia, the axial length is more than normal while in case of hypermetropia, axial length is less than normal. Also, the axial length is a strong predictor of progression of refractive errors. Axial length can be measured by ultrasonic A- scan method by contact or immersion method; or by optical biometer. Optical biometer is more accurate and easier to use in measuring axial length as it is non-contact method of measurement.

Many studies suggest increasing trend of refractive errors among children. The exact causes of refractive errors in children remain unknown. There are multiple factors associated with refractive errors. Some of them are genetic correlation, poor nutrition, lack of outdoor activities, excessive use of electronic gadgets etc. Myopia is refractive error in which children can see near objects clearly but distant objects are seen blurred. In case of hypermetropia both near and distant objects are seen blurred. Hypermetropia, if remain uncorrected, may lead to form accommodative squint. Both type of refractive error may be either isolated myopia or hypermetropia or may present in association with astigmatism. Astigmatism is a condition of difference in corneal curvature in both the axis, horizontal and vertical, of cornea. Cylindrical lenses are required to correct astigmatism. If these children remain unattended and do not consult ophthalmologist or optometrist after attainment of certain age, it may lead to secondary visual impairment known as amblyopia or lazy eyes. They may present with unilateral or bilateral amblyopia. If this refractive error is not corrected up to age of 8 years, the visual impairment may become permanent as macular area attains maturity by the age of 8 years. On the other hand, timely intervention may improve final visual outcome in most of cases. Uncorrected refractive error is one of the most important causes of visual impairment worldwide especially in younger age group.

The present retrospective hospital based clinical study was aimed at assessing the demographic profile, prevalence, and pattern of refractive errors in children of age group 03 to 17 years.

The present retrospective hospital based clinical study was aimed to assess the demographic profile, prevalence, and pattern of refractive errors in children of age group 3 to 17 years and correlation of refractive errors with axial length of eyes, attending eye OPD at tertiary care hospital in north India.

Materials and Methods

This study was conducted on the subjects visited to the Department of Ophthalmology, Post Graduate Institute of Child Health, Noida, Uttar Pradesh. All patients from age group 3 years to 17 years were examined and their presenting complaints and visual acuity with spectacles and without spectacles whenever possible were recorded. Demographic and clinic data on the patients' first visit to the eye department were recorded and these included their age, gender, location, presenting visual acuity (VA), refractive status and its correction.

Consent waiver was taken from CPSCO and DHR approved Institutional Ethical Committee (IEC) as nature of study was retrospective data analysis. The study included 829 patients aged 3 to 17 years old with refractive errors, divided into only myopia (229 subjects), myopia along with astigmatism (465 subjects) only hypermetropia (30 subjects), and hypermetropia with astigmatism (105 subjects) during span of last five years.

Inclusion criteria: The inclusion criteria for the study were subjects in the age range of 3 to 17 years, attending eye opd.

Exclusion criteria: all the patients who were uncooperative, had undergone previous ocular surgery, having any anterior segment disorder like corneal opacity, cataract, corneal ulcer, or injury was not included in study. Patients with posterior segment disorders like retinal detachment were not included. Children having other disorders which hinder recording of visual acuity, like cerebral palsy patients, mentally retarded patients were also not included in study.

Procedure

After final inclusion of the study subjects, detailed history was taken from all the participants followed by a comprehensive ocular examination. In all the subjects, the post-mydriatic test and cycloplegic refraction test were done manually by a single refraction expert in the field. ETDRS chart was used to assess the refractive status and the distant visual acuity with the subjects seated at 4 meters distance and it was recorded in log MAR units. A Jaeger chart was used to record the near vision, followed by the cycloplegic refraction. Then we performed dry retinoscopy and recorded auto refractokeratometry (ARK) readings, type of refractive error whether myopia or hypermetropia, with or without astigmatism, carried out cycloplegic refraction using 2% homatropine or cyclopentolate 1% eye drops, depending upon age of patients. Following that wet retinoscopy with streak retinoscope, (ARK) were done and detailed retinal examination was performed to rule out any underlying retinal pathology causing diminution of vision. Meticulous fundus and slit-lamp examination were done for all the subjects using the slit-lamp biomicroscopy and indirect and direct ophthalmoscopy using a 20-D and 90-D lens to rule out any existing anterior segment or posterior segment pathology. Final refraction was carried out after 3 days when effect of cycloplegic drugs subsided completely. After prescribing suitable spectacles, we recorded the best corrected visual acuity at that time. Also recorded whether patient was amblyopic or not. Additionally, we recorded whether status of both eyes is isometropic or anisometropic. In all the study subjects, the spherical component with ½ cylinder component comprising spherical equivalent was calculated. Difference of Spherical equivalent refraction (SER) > 1.50D and/or cylinder equivalent refraction (CER) > 1.0 D between both eyes was recorded as state of anisometropia. Amblyopia was taken as a difference in visual acuity of 2 or more lines on the ETDRS (Early Treatment Diabetic Retinopathy Study) chart between the two eyes; or visual acuity of 6/12 or worse bilaterally. Axial length was measured using an optical biomicroscope and was recorded.

Statistical Analysis

The collected data was statistically evaluated using SPSS software version 21.0, an independent t-test, and a one-way ANOVA (analysis of variance) test. The information was presented in the form of numbers and percentages, as well as mean and standard deviation. A p> 0.05 was judged statistically significant.

Results

The study included 829 patients aged 3 to 17 years old with Refractive Error. 13.51% (n=112), 26.89% (n=223), 24.96% (n=207), 23.03% (n=191) and 11.58% (n=96) of study subjects were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years, with a mean age of 7.8 years and an SD of 3.21 (ranging from 03 to 17 years) and a p value of <0.001 (Table 1).

Table 1: Profile of Refractive Error cases with different age group

Age group	Frequency	xm	f*xm	f*xm^2		
3 to 5	112	4	448	1792		
6 to 8	223	6	1338	8028	**Mean**	7.85
9 to 11	207	8	1656	13248	**p-value**	<0.001
12 to 14	191	10	1910	19100	**Variance**	10.32
15 to 17	96	12	1152	13824	**SD**	3.21
	829		**6504**	**55992**		

Out of 829 patients aged 3 to 17 years old with Refractive Error, 229 cases were observed with myopia and further 721 subjects were myopia with astigmatism and 124 subjects were myopia with amblyopia. In the myopia group, 3.93% (n=9), 12.66% (n=29), 26.21% (n=66), 28.82% (n=76) and 21.39% (n=49) study subjects were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years, with a mean age of 9.11 years and an SD of 0.78 (ranging from 03 to 17 years) and a p value of <0.001 (Table 2).

Table 2: Myopia

	Frequency	xm	f*xm	f*xm^2		
03 to 05	9	4	36	144		
06 to 08	29	6	174	1044	**Mean**	9.11
09 to 11	66	8	528	4224	**p-value**	<0.001
12 to 14	76	10	760	7600	**Variance**	0.61
15 to 17	49	12	588	7056	**SD**	0.78
	229		**2086**	**20068**		

In the myopia with astigmatism group, 15.48% (n=72), 29.03% (n=135), 24.73% (n=115), 21.29% (n=99) and 9.46% (n=44) study subjects were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years, with a mean age of 7.60 years and an SD of 1.78 (ranging from 03 to 17 years) and a p value of <0.001 (Table 3).

Table 3: Myopia with astigmatism group

	Frequency	xm	f*xm	f*xm^2		
03 to 05	72	4	288	1152		
06 to 08	135	6	810	4860	**Mean**	7.60
09 to 11	115	8	920	7360	**p-value**	<0.001
12 to 14	99	10	990	9900	**Variance**	3.17
15 to 17	44	12	528	6336	**SD**	1.78
	465		**3536**	**29608**		

Similarly, in the myopia with amblyopia group, 11.29% (n=14), 26.61% (n=33), 21.77% (n=27), 29.03% (n=36) and 11.29% (n=14) study subjects were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years, with a mean age of 8.05years and an SD of 0.47 (ranging from 03 to 17 years) and a p value of <0.001 (Table 4).

Table 4: Myopia with amblyopia group,

	Frequency	xm	f*xm	f*xm^2		
03 to 05	14	4	56	224		
06 to 08	33	6	198	1188	**Mean**	8.05
09 to 11	27	8	216	1728	**p-value**	<0.001
12 to 14	36	10	360	3600	**Variance**	0.23
15 to 17	14	12	168	2016	**SD**	0.47
	124		**998**	**8756**		

Similarly, only 30 cases were observed with hypermyopia and 105 subjects were hypermyopia with astigmatism and 46 subjects were hypermyopia with amblyopia. In the hypermyopia group, 11.29% (n=3), 46.66% (n=14), 26.66% (n=8), 13.33% (n=4) and 3.33% (n=1) study subjects were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years, with a mean age of 7.07 years and an SD of 0.09 (ranging from 03 to 17 years) and a p value of <0.001 (Table 5).

Table 5: Hypermetropia

	Frequency	xm	f*xm	f*xm^2		
03 to 05	3	4	12	48		
06 to 08	14	6	84	504	**Mean**	7.07
09 to 11	8	8	64	512	**p-value**	<0.001
12 to 14	4	10	40	400	**Variance**	0.01
15 to 17	1	12	12	144	**SD**	0.09
	30		**212**	**1608**		

Similarly, in the group of hypermetropia with astigmatism, 26.66% (n=28), 42.87% (n=45), 17.14% (n=18), and 11.42% (n=12) and 1.90% (n=2) study subjects were of the age group of 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 with a mean age of 6.38 years and an SD of 0.34 (ranging from 03 to 17) with a p value of <0.001 (Table 6).

Table 6: Hypermetropia with astigmatism

	Frequency	xm	f*xm	f*xm^2		
03 to 05	28	4	112	448		
06 to 08	45	6	270	1620	**Mean**	6.38
09 to 11	18	8	144	1152	**p-value**	<0.001
12 to 14	12	10	120	1200	**Variance**	0.11
15 to 17	2	12	24	288	**SD**	0.34
	105		**670**	**4708**		

Similarly, in the hypermetropia with amblyopia group, 17.39% (n=8), 48.88% (n=22), 19.56% (n=9), 13.04% (n=6) and 2.17% (n=01) study subjects were aged 03 to 05, 06 to 08, 09 to 11, 12 to 14 and 15 to 17 years, with a mean age of 6.70 years and an SD of 0.14 (ranging from 03 to 17 years) and a p value of <0.001 (Table 7).

Table 7: Hypermetropia with amblyopia group

	Frequency	**xm**	**f*xm**	**f*xm^2**		
03 TO 05	8	4	32	128		
06 to 08	22	6	132	792	**Mean**	6.70
09 to 11	9	8	72	576	**p-value**	<0.001
12 to 14	6	10	60	600	**Variance**	0.02
15 to 17	1	12	12	144	**SD**	0.14
	46		**308**	**2240**		

The data was further examined with regard to myopia and hypermetropia, in combination with axial length of the eyeball. Out of 694 cases of myopia in right eye, there were 5, 353, 279, 48, and 9 cases with axial lengths of 19 to 20 mm, 21 to 22 mm, 23 to 24 mm, 25 to 26 mm, and 27 to 28 mm, respectively. The mean axial length was 23.14 mm, and the standard deviation was 1.52 mm (ranging from 19 to 29), with a p value of <0.001 (Table 8).

Table 8: Myopia (Axial Length R/E = mm)

	Frequency	**xm**	**f*xm**	**f*xm^2**		
19.00 to 21.00	5	20	100	2000		
21.01 to 23.00	353	22	7766	170852	**Mean**	23.14
23.01 to 25.00	279	24	6696	160704	**p-value**	<0.001
25.01 to 27.00	48	26	1248	32448	**Variance**	2.30
27.01 to 29.00	9	28	252	7056	**SD**	1.52
	694		**16062**	**373060**		

Axial length on the left eye was found that 2, 349, 284, 50, and 8 cases, respectively, had axial lengths of 19 to 21 mm, 21 to 23 mm, 23 to 24 mm, 23 to 25 mm, 25 to 27 mm and 27 to 29 mm with mean axial lengths of 23.17 and 1.50 (ranging from 19 to 28) and p value of <0.001 (Table 9).

Table 9: Myopia (Axial Length L/E = mm)

	Frequency	**xm**	**f*xm**	**f*xm^2**		
19.00 to21.00	3	20	60	1200		
21.01 to 23.00	349	22	7678	168916	**Mean**	23.17
23.01 to 25.00	284	24	6816	163584	**p-value**	<0.001
25.01 to 27.00	50	26	1300	33800	**Variance**	2.25
27.01 to 29.00	8	28	224	6272	**SD**	1.50
	694		**16078**	**373772**		

Out of 134 cases of hypermetropia, the right eye's axial length was measured in 32, 79, 19, 4, and 0 cases, respectively, with axial lengths of 19 to 20 mm, 21 to 22 mm, 23 to 24 mm, 25 to 26 mm, and 27 to 28 mm. The mean axial length was 21.45 mm, and the standard deviation was 0.32 mm (ranging from 19 to 28) and their p value was <0.001 (Table 11).

Table 11: Hypermetropia (Axial Length R/E)

	Frequency	**xm**	**f*xm**	**f*xm^2**		
19.00 TO 21.00	32	20	640	12800		
21.01 to 23.00	79	22	1738	38236	**Mean**	21.93
23.01 to 25.00	19	24	456	10944	**p-value**	<0.001
25.01 to 27.00	4	26	104	2704	**Variance**	0.09
27.01 to 29.00	0	28	0	0	**SD**	0.30
	134		**2938**	**64684**		

Out of 134 cases of hypermetropia with the left eye's axial length, 32 cases were found to have an axial length of 19 to 21 mm, 82 cases to be 21 to 23 mm, 16 cases to 23 mm to 25mm, 3 cases to 25 mm to 27mm, and 1 case to be 27 cases to 28 mm, with a mean axial length of 21.43 mm and an SD of 0.31 mm (ranging from 19 to 28) and a p value of <0.001 (Table 12).

Table 12: Hypermetropia (Axial Length L/E)

	Frequency	**xm**	**f*xm**	**f*xm^2**		
19.00 to 21.00	32	20	640	12800		
21.01 to 23.00	82	22	1804	39688	**Mean**	21.90
23.01 to 25.00	16	24	384	9216	**p-value**	<0.001
25.01 to 27.00	3	26	78	2028	**Variance**	0.09

27.01 to 29.00	1	28	28	784	**SD**	0.30
	134		**2934**	**64516**		

The study participants ranged in age from 3 to 17 years, and their mean age was 7.92 years; their standard deviation was 4.12 years, and their p value was <0.001 (**Table 13).** In the current study, there were 47.70% (n=509) female and 52.29% (n=559) males participants. In the study groups, there were no discernible differences in terms of gender or age.

Table 13: Patients selected for the study in Age group

Age group (Years)	**Frequency**		
3 to 5	131		
6 to 8	291	**Mean**	7.92
9 to 11	268	**p-value**	<0.001
12 to 14	250	**Variance**	16.99
15 to 17	130	**SD**	4.12
Total	**1070**	**p-value**	<0.001

Discussion

The study findings revealed that, 26.89% cases of 06 to 08 age groups found highest Refractive Error cases in comparison to study subjects with aged 03 to 05, 09 to 11, 12 to 14 and 15 to 17 years. Further, the study findings revealed that the myopia with astigmatism group was 81.47% with a mean age of 7.60 years and an SD of 1.78 (ranging from 03 to 17 years) with a p value of <0.001 showed higher than the other group 18.4% hypermetropia with astigmatism, with a mean age of 6.38 years and an SD of 0.34 (ranging from 03 to 17) with a p value of <0.001. These findings were consistent with previous research by Kedir, J., & Girma, A. et al in 2014,[5] who found that the prevalence of myopia, hyperopia, and astigmatism in NHW children was 1.20% (95% CI = 0.76-1.89%), 25.65% (95% CI = 23.5-27.9%), and 6.33% (95% CI = 5.21-7.68%) respectively.

An emmetropic eye typically has an axial length of 16.5 mm at birth similar to the studies conducted by Saara, K. et al [6] in 2022, and 23.5 mm or so in adulthood as shown in the study conducted by Tideman, J. W. et al [7] in 2016. In this study observed that, Myopia with axial length on right eye found 0.72%, 54.39%, 40.20%, 6.91% and 1.2% of cases respectively were of 19 to 21 mm, 21 to 23 mm, 23 to 25 mm, 25 to 27 mm and 27 to 29 mm axial length with a mean axial length of 23.14 and an SD of 1.52 with p value of <0.001, whereas myopia with axial length on left eye found 0.40%, 50.28%, 40.92%, 7.2% and 1.15% cases respectively were of 19 to 21 mm, 21 to 23 mm, 23 to 25 mm, 25 to 27 mm and 27 to 29 mm axial length with a mean axial length of 23.17 and an SD of 1.50 (ranging from 19 to28) with p value of <0.001.

Similarly in the of cases of hypermetropia with axial length of right eye found 23.88%, 58.95%, 14.17% and 2.98% of cases respectively were of 19 to 21 mm, 21 to 23 mm, 23 to 25 mm, 25 to 27 mm and 27 to 29 mm axial length with a mean axial length of 21.9 and an SD of 0.30 (ranging from 19 to 29) with p value of <0.001 and hypermetropia with axial length of left eye found 23.88%, 61.99%, 11.94%, 2.23% and 0.74% of cases respectively were of 19 to 21 mm, 21 to 23 mm, 23 to 25 mm, 25 to 27 mm and 27 to 29 mm axial length with a mean axial length of 21.90 and an SD of 0.30 (ranging from 19 to 29) with p value of <0.001. Tideman et al. [7] in 2016, Found that an axial length of 26 mm or more was related with a one-in-three risk of vision impairment by age 75, while an axial length of 30mm or more was associated with a 90% chance of visual impairment. According to the same study, while there was a high association between axial length and myopic status of eye, it only explained about 70% of the variation in axial length.

The study participants ranged in age from 3 to 17 years, and their mean age was 7.92 years; their standard deviation was 4.12 years, and their p value was of <0.001. In the current study, there were 52.29% (n=559) male participants and 47.70% (n=509) female participants. In the study groups, there were no discernible differences in terms of gender or age. In the Correction of Myopia Evaluation Trial (COMET) Study, Kedir, J., & Girma, A. et al in 2014, [5] and Hou et al.[2] in 2018 an ethnically varied cohort showed myopic eye development from ages 8-11 years, for an annual average of little over 0.3mm per year. Myopes who were still progressing at the ages of 13 to 16 years showed around half of this axial progression, with 00.5±0.1mm over three years or approximately 0.17mm per year.

Based on the data collected, we conclude that the axial length has been well established as a significant parameter in studying the progression and control of myopia. Wolffsohn et al. [8] in 2019 reported that, it is also regarded as the gold standard for determining the efficacy of myopia management therapy, and as a clinical assessment, it may be up to ten times more sensitive than refraction in detecting myopia progression.

Conclusion

The study findings revealed that, 06 to 08 age groups having maximum number of patients of refractive error followed by 09 to 11 years of age. The axial length and its progression can be used as important parameter to monitor and manage myopia. Progression of axial length appears to be a higher risk factor than refraction alone for future myopia-related vision impairment. Axial length may therefore can be used as monitoring parameter of progression of myopia especially in case of high degree of myopia like pathological myopia which can lead to developing myopia-related vision impairment in the future.

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