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Original Research Article

Incidence and progression of myopia in children (0 – 15 years) with reference to causes and risk factors in a tertiary eye care centre in central India

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ABSTRACT

Aim: To study the causes and risk factors for development of myopia and to see short term progression in children of 0 – 15 years.

Settings and Design: A prospective observational study was conducted among children attending the Ophthalmology department of a Tertiary care centre in Central India, from October 2019 to September 2021.

Methods and Material: In order to determine the refractive status of the eye, all subjects underwent visual acuity tests, anterior and posterior segment examinations, and various other investigations. Data was collected during the first year concerning their parents' use of spectacles, duration of indoor activity near work, and outdoor activity, and progression was tracked during the second year. Statistical software SPSS 23.0 version was used to tabulate and analyze the data.

Results: Amongst 714 children between the age 0 – 15 years, myopia was seen in 19.9% subjects. Amongst those with myopia, 28% showed progression. In those showing progression, 50% belonged to 11 – 15-year age group, a female predilection of 64.3%, 50% with parental history of refractive error, 71.4% subjects were involved in > 2 hours/day of indoor active near work and 57.1% subjects were involved in < 2 hours/day of outdoor activity. In subjects with progression of myopia, 71.4% had an increase in axial length of < 1 mm. While in subjects less than 10 years of age, steeper cornea was a more common factor for progression as compared to increase in axial length, seen in 57.1% cases.

Conclusion: Myopia progression in the growing age group is inversely correlated with time spent engaging in outdoor activity, on the other hand, it shares a strong positive correlation with time spent on indoor active near work. Corneal curvature plays a more significant role in progression of myopia as compared to axial length in younger age group.

1. Introduction

The most common cause of visual impairment around the world is refractive error (RE), which is also the second leading cause of treatable blindness, with myopia being the commonest refractive error.

Myopia is the most common ophthalmic condition in the world with an estimated 22.9% of the world population, or 1.406 billion people, being affected.[1,2] Myopes carry higher risks of ocular morbidity including retinal detachment, glaucoma, myopic macular degeneration, and cataracts.[3] Correspondingly, un correctable visual impairment is estimated to increase 7-fold to 13-fold by 2055 in high-risk areas.[4] Many East Asian countries are particularly affected, where the prevalence of myopia in school children exceeds

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90% in some regions.[5–7] Apart from physiological factors, genes and other environmental factors also play a role in the onset and progression of myopia. Prior studies have demonstrated an association between myopia and near-work activities such as studying, reading, and screen time among children.[8]

Additionally, time spent outdoors has been shown to be protective against myopia.[9] potentially due to light stimulation of retinal dopamine which discourages axial growth.[10] In this field of study where there continues to be controversies in etiology, there is recent agreement that children who spend more time outdoors are less likely to become myopic.

While myopia is often considered a benign condition it should be considered a public health problem for its visual, quality of life, and economic consequences.[11] Studies related to incidence and progression of myopia is scarce in this part of the country, hence this study was planned to evaluate the incidence and progression of myopia with special reference to causes and risk factors, which will provide insights to the better management of myopes.

2. Materials and Methods

A prospective observational study was undertaken wherein all subjects aged 0-15 years, attending Ophthalmology department of a tertiary care centre in Central India from October 2019 to September 2021, willing to participate and those with no history of use of spectacles, were included in the study after explaining the procedure properly and taking written and informed consent from the respective parents/guardians. Subjects aged greater than 15 years, not willing to participate, previously diagnosed of having refractive error or with history of previous intraocular surgery or trauma or other ocular diseases were excluded from the study. The study was undertaken after approval from the Institutional Ethics Committee.

The first year was allotted to data acquisition regarding establishment of subjects with myopia, with follow up in the next one year to look for progression and the factors influencing it.

Detailed history was taken regarding use of spectacles and presence or absence of pre-existing refractive error in mother and/or father. For children more than 5 years of age, detailed history regarding the duration of indoor and outdoor activities were taken and average duration was recorded based on last 1 week recall. The subject's indoor activities involving active near work (including reading/ writing, indoor games involving active near work, use of TV, mobile phones, computer for various purposes like playing video games, watching videos, or attending online classes) and outdoor activities, if yes, the duration spent doing each, were asked and recorded respectively. The results of the duration spent on indoor as well as outdoor activities were tabulated as less than and more than 2 hours for ease of computation, depending upon the mean average of the number of hours spent on the same per day, rounded off to the closest possible whole number, based on the account given by the parents of the subjects for the last 1-week recall.

Visual Acuity assessment, Anterior and posterior segment examination followed by wet retinoscopy, refraction, automated refractometry, A scan, B scan, Applanation tonometry, pachymetry and video keratography findings were recorded.

The subjects with progression of myopia were given proper spectacle correction, were closely monitored for compliance as well as for complications, and were managed according to the institution's treatment protocol. As this study was an observational study with focus on causes and risk factors for progression, treatment portion was not included for data compilation as part of the study.

2.1. Statistical analysis

Data collection proforma was made and data was collected and entered in MS Excel sheet. All the variables were grouped into, as per mathematic transformation of them into nominal/ Ordinal. Chi square test was applied at appropriate places, where categorical data was analysed. A p-value of <0.05 was assigned as statistically significant.

3. Results

A total of 714 subjects participated in the study, of which 19.9% of them had myopia at the time of the initial examination. The gender predilection was determined to be 53.5% female against 46.5% male. Majority of the subjects, or 46.5%, were between the ages of 6 and 10; the rest were of either age groups with a slight preponderance towards the higher end of the age limit.

Table 1 shows that among 714 children between the age 0 -15 years, in those showing progression, a major portion belonged to the 11-15-year age group. A female predilection was noted along with an equal distribution of subjects with parental history of refractive error. A strong positive correlation was seen in subjects involved in > 2 hours/day of indoor active near work and an inverse correlation was seen in subjects involved in < 2 hours/ day of outdoor activity.

The Table 2 shows that in a younger age group, corneal curvature plays a major role in progression as compared to axial length, whereas the same does not hold true for the higher end of the growing age group.

4. Discussion

In the present prospective observational study, 19.9% were found to be having myopia, whereas majority of the subjects were found to be hypermetropic. The age wise distribution of the subjects showed maximum subjects having myopes belonging to 1-5 years age group, of which 4 subjects showed progression, whereas maximum number

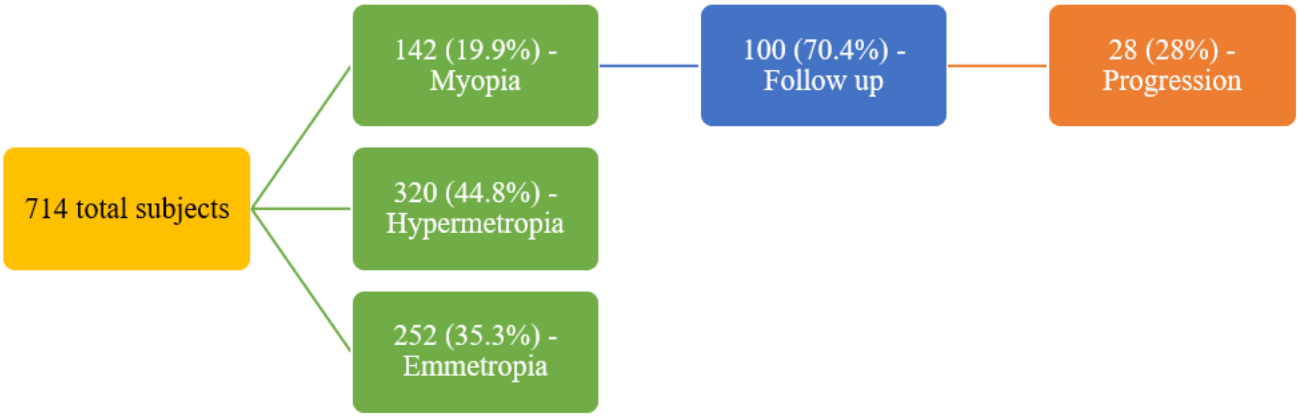

Fig. 1: Flowchart for subject distribution in the study

Table 1: Distribution of subjects according to co-relation between age, gender, refractive status of the parents, usage of screens, duration spent on indoor active near work and outdoor activity, axial length and corneal curvature with progression of myopia

Age Group (in years)	**Visits**						**Chi Square statistic P Value**
	First Visit		**Follow up visit**		**Progression**		
≤5	n	%	n	%	n	%	
6.10	32	22.5	22	22.0	4	14.3	4.4216
11-15	66	46.5	48	48.0	10	35.7	0.3519
Gender							
Male	66	46.5	44	44.0	10	35.7	1.1103
Female	76	53.5	56	56.0	18	64.3	0.5739
Family history							
Father	12	8.5	10	10.0	2	7.1	4.0213
Mother	22	15.5	20	20.0	8	28.6	
Both	20	14.1	10	10.0	4	14.3	0.6737
None	88	62.0	60	60.0	14	50.0	
Usage of screens							
Present	122	85.91	56	56	16	57.15	29.3062
Absent	20	14.08	44	44	12	42.85	<0.00001
Duration spent on indoor active near work							
≤2 hrs / day	84	59.20	34	34	8	28.57	19.1
>2 hrs / day	58	40.80	66	66	20	71.43	0.000074
Duration spent on outdoor activity							
≤2 hrs/ day	86	60.6	82	82	16	57.1	14.1652
>2 hrs/ day	56	39.4	18	18	12	42.9	0.00084
Axial Length (in mm)							
≤21	10	7.0	6	6	0	0.0	21.3689
22-23.9	110	77.5	54	54	24	85.70	0.000023
≥24	22	15.5	40	40	4	14.30	
Corneal Curvature (in D)							
K1 Values (IN D)	N	%	N	%	N	%	
<44	76	53.5	52	52	16	57.1	0.242
≥44	66	46.5	48	48	12	42.9	0.993
K2 Values (IN D)							
<44	72	50.7	46	46	14	50.0	0.407
≥44	70	49.3	54	54	14	50.0	0.981

Table 2: Co-relation of change in corneal with increase in axial length according to age

Age Group	Increase in Axial Length	Change in Corneal Curvature			Total N (%)	Chi Square	P value
		< 0.5D N (%)	0.5 – 1D N (%)	> 1 D N (%)			
Less than 10 years	< 1 mm	2 (20.0)	6 (60.0)	1 (20.0)	10 (100.0)	1.633	0.4419
	1 – 3 mm	2 (50.0)	1 (25.0)	1 (25.0)	4(100.0)		
More than 10 years	< 1 mm	7 (70.0)	2 (20.0)	1 (10.0)	10 (100.0)	2.3625	0.3068
	1 – 3 mm	1 (25.0)	2 (50.0)	1 (25.0)	4(100.0)		

of subjects of this age group, were hypermetropes, owing to physiological reasons like smaller axial length and flatter cornea. The results are comparable to the hospital based cross sectional study conducted by Gupta R et al. (2013)[12] to evaluate the prevalence of Myopia in children up to 16 years wherein, prevalence of childhood myopia was 16.5%.

The findings of our study were found inconsistent in regards to incidence, with a study conducted by Agarwal D et al (2020),[13] on the prevalence of myopia in Indian school children, which included data from 59 quality assessed studies, covering nearly 1,66,000 urban and 1,20,000 rural children, where the overall crude prevalence of myopia over the last four decades was found to be 7.5% (95% CI, 6.5–8.5%) in the 5-15-year age group.

In the current study, progression of myopia was seen in 28 (28%) of the 100 subjects who showed for follow up. On the other hand, in the prospective longitudinal study conducted by Rohit Saxena et al. (2017),[14] progression of myopia was seen in 4731 (49.2%) children.

In our study, majority of the subjects with progression of myopia, had a positive history for excess usage of screens. Among those, a larger portion of subjects had a screen time of more than 2 hours and outdoor activities of less than 2 hours. This distribution indicates, outdoor activity for > 2 hours and indoor activity of < 2 hours is less likely to cause progression.

Our findings were similar to a cross-sectional study conducted by Umamaheswari Kannan et al (2016)[15] among school children in the age group of 6-12 years, where duration of watching television (TV), distance from which TV was watched, duration of computer/video/mobile games, and the duration of play outside had a statistically significant association to the prevalence of RE.

The current study also shows findings similar to a prospective longitudinal study conducted by Rohit Saxena et al (2017),[14] where hours of reading-writing/week ($p<0.001$), use of computers/ video games ($P<0.001$) and watching television ($P = 0.048$) were significant risk factors for progression of myopia. Outdoor activities / time spent outdoors> 2 hours in a day were protective with an inverse association with progression of myopia ($P< 0.001$).

In the study undertaken, most of the subjects were having axial length of 22-23.9 mm, which was found to be significant statistically with a p value of <0.05.

In this study, when increase in axial length was compared to change in corneal curvature in subjects less than 10 years of age, showing progression, it shows that change in corneal curvature is a more common factor for progression of myopia in younger children (< 10 years), that is, steeper cornea is more common. Also, when increase in axial length was compared to change in corneal curvature in subjects more than 10 years of age, showing progression, it does not provide a valid conclusion, whether any of the above factors is more common in the subjects showing progression in this age group, which can be attributed to small sample size. This can be ascribed to the physiological changes in the which occurs until 10 years of age. No recent or past studies have been done on the correlation between increase in axial length and change in corneal curvature with respect to age, as a factor for progression. Hence, this study paves the way and forms the basis for future studies to be carried out on the subject of myopia, where the above factor can be explored on a larger sample size and a population-based study design.

5. Conclusion

In this study, we found that in the younger age group (<10 years), curvature myopia was a more common factor for progression as compared to axial myopia, which can be attributed to the physiological changes of the eye with the increasing age. Hence, physiological risk factors like longer axial length with faster increase in the same, and change in corneal curvature should be looked for carefully to check progression. It has also highlighted that apart from the common physiological factors, environmental factors, like time spent on indoor and outdoor activity also play a significant role in the progression of myopia in paediatric population. Adequate short - term follow - up planned at 6 months and 1 year should be done for providing timely refractive correction and thus prevention of Amblyopia.

Though this study is a single centre hospital-based study, with a short term follow up and smaller size, however, it provides basis and paves the way for future studies to be conducted about refractive errors, especially myopia, where population - based studies would be more insightful as to the natural course of the disease and for results with external validity.

6. Source of Funding

None.

7. Conflict of Interest

None.

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