

Myopia prevalence in a population-based childhood visual impairment study in North India - CHVI-2

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Purpose: The aim of the study was to determine the prevalence of myopia at the community level. **Methods:** A population-based, cross-sectional study was planned in 40 clusters among children identified with subnormal vision in the urban community of Delhi. House-to-house visits were conducted for visual acuity screening of 20,000 children aged 0–15 years using age appropriate visual acuity charts. All the children with visual acuity of < 6/12 in any eye in the age group between 3 and 15 years and inability to follow light in age group 0–3 years were referred for detailed ophthalmic examination. **Results:** A total of 13,572 (64.7%) children belonged to the age group of 6–15 years. Of these, a total of 507 (3.7%) were found to be having myopia (spherical equivalent of -0.50 DS or worse in one or both eyes) with positive association with higher age groups. **Conclusion:** The estimated prevalence of myopia is 3.7%; the proportion of uncorrected myopia was 45%, which reflects that refractive error services need to be improved further.

Key words: Myopia, refractive error, visual impairment

Myopia is the most important cause of visual impairment in children worldwide.^[1] The prevalence of myopia varies across countries between 10 and 30%. In India, this prevalence varies according to different study settings like in community-based settings; it has been recorded between 4 and 10%, while, in school-based studies, it has been recorded between 10 and 20%.^[2-9] Most of the studies related to myopia available in world including India are school based with only a few studies available, which are conducted in community-based settings.^[1,4] One of the most reliable method to estimate true prevalence of myopia is by conducting community-based studies to reach all the underprivileged children and children with disabilities who are not able to attend the schools. This study was undertaken to determine the prevalence of myopia in children in a community-based setting and to identify the risk factors responsible for occurrence of myopia in children.

Though various studies on myopia estimate that myopia is becoming an ever-emerging epidemic and nearly half of the population will be myopic in the whole world by 2050, the prevalence of myopia has increased but the age at which it appears has reduced. Additionally, this rate of progression of myopia seems to be higher in Asia than in other parts of the world. Progression of myopia in children is related to genetic factors, pollution, life style, living environments, decreased

outdoor activity, and increased time spent on electronic devices in the form of computer and phone.^[10-24]

Methods

This cross-sectional community-based study was done using cluster random sampling. It was conducted between July 2015 and December 2017 to determine the visual impairment amongst children aged less than 16 years. The study was conducted in Trilokpuri area in East Delhi. The population was calculated from census 2011.

A total sample size of 20,000 was calculated for the whole study using a precision of 0.12, design effect of 2, and response rate of 90%. A computerized simple random sampling approach was used to select 40 clusters. A total of 20,955 children were examined in age less than 15 years from the 40 randomly selected clusters. A house-to-house visit was made to each family in the selected clusters. The study was conducted after taking the ethical approval from the Institute Ethics Committee, in June 2015. A written informed consent was taken from parents of all the children enrolled for the study in accordance with the protocol of Helsinki. A participant information sheet explaining the study aims and objectives, the detailed procedure that was to be carried out and any adverse effects of dilatation, was explained to all the parents or caretakers of children participating in the study. A detailed house-to-house survey was conducted by

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the optometrists who were involved in the survey after providing them with 1-week training on visual acuity assessment and study-related procedures. The inclusion criteria for the study included children aged less than 16 years, parents or caretakers willing to provide informed and written consent, and children cooperative for visual acuity examination. The exclusion criteria included mentally retarded children and refusals. Visual acuity estimation was done using 6/12 optotype of logMAR E chart in children aged between 6 and 15 years and Lea Symbol chart of 6/12 optotype in children aged between 3 and 5 years; both the charts were used at a distance of 3 m. Besides this, socioeconomic status was elicited using modified Kuppuswamy criteria that included occupation, education of head of household, and family income per month.^[13] The children who were not able to communicate and parents of children refusing for giving consent were excluded from the study.

All children detected with unaided visual acuity of less than 6/12 in any eye, who were referred to a central clinic for cycloplegic refraction by an optometrist and detailed ophthalmic examination by the ophthalmologist. In the clinic, refraction was done under ambient room lighting. Detailed vision on ETDRS chart at a distance of 4 m was recorded, first in the right eye followed by the left eye. In children already wearing glasses, power of glass was noted using lensometer and refraction was performed to check if further improvement was required in case the child's vision was less than 6/12.

For the current study, the prevalence and risk factors for myopia were estimated in children aged 6–15 years as myopia is considered as a significant problem in this age group.^[9] Refraction was done in two stages; in the first stage, under cycloplegia using 2% homatropine eye drops, the second stage was a postmydriatic test for prescribing the final prescription of glasses based on subjective acceptance. Homatropine 2% eye drops were instilled in the inferior cul-de-sac twice at an interval of 10 min before refraction. If the pupillary reflex was still present after 20 min, a third drop was administered. Cycloplegia was considered complete if pupil was dilated to 6 mm or more, and there was no evidence of pupillary light reflex. Retinoscopy was done using a streak retinoscope (Heine, Germany) and based on the findings of refraction under dilatation, subjective refraction was done at a follow-up visit after 48 h and final power of glass was prescribed. All the children were provided with glasses free of cost.

All the children underwent anterior and posterior segment examination using slit lamp, direct and indirect ophthalmoscopy by an ophthalmologist, and were further managed in a tertiary care facility, in case if any treatment was required.

Definitions used in the study

Corrected refractive error included those children who were able to read 6/12 with their glasses in both the eyes. Children who could not read 6/12 with their glasses were considered as uncorrected refractive error along with the children whose vision was less than 6/12 and were not wearing glasses.

Myopia was defined as spherical equivalent of -0.50 DS or worse in one or both the eyes. Spherical equivalent was calculated by adding the sum of spherical power with half of cylindrical power. Children were considered myopic if one or both eyes were myopic.

Statistical analysis

The statistical analysis was done using STATA software 14.0 (College station USA) and epi info. The quantitative data has been described as number (%) and mean \pm SD and median along with range. The multilogistic regression was done to find the association between demographic data factors and myopes. The data was reported as odds ratio (95% CI). A value of $P < 0.05$ was considered as significant.

Results

Socio demographic profile

This cross-sectional study was conducted in 40 clusters in East Delhi; a total of 13,931 children were enumerated in the age group of 6–15 years. Of these, 7128 (52.5%) were males and 6444 (47.5%) were females. There were 4256 (31.4%) children belonging to the age group between 6 and 8 years, followed by 4073 (30.0%) children belonging to the age group between 9 and 11 years, followed by 2857 (21.0%) children belonging to the age group between 12 and 13 years, and 2386 (17.6%) children belonging to age group between 14 and 15 years.

Prevalence of myopia

Of the 13,931 children enumerated, a total of 13,572 (97.4%) underwent detailed visual acuity examination using log Mar E chart in the field. Of these 13,572 children, a total of 739 (5.4%) children with visual acuity $< 6/12$ in the worse eye were referred to the clinic; only 678 of 739 (91.8%) children reached the clinic. After refraction at the clinic site, a total of 507 (3.7% CI) children were found to be having myopia (spherical equivalent of -0.50 DS or worse in one or both the eyes).

A total of 259 (51.1% male and 248 (48.9%) female children were myopic [Fig. 1]. The mean age of children with myopia

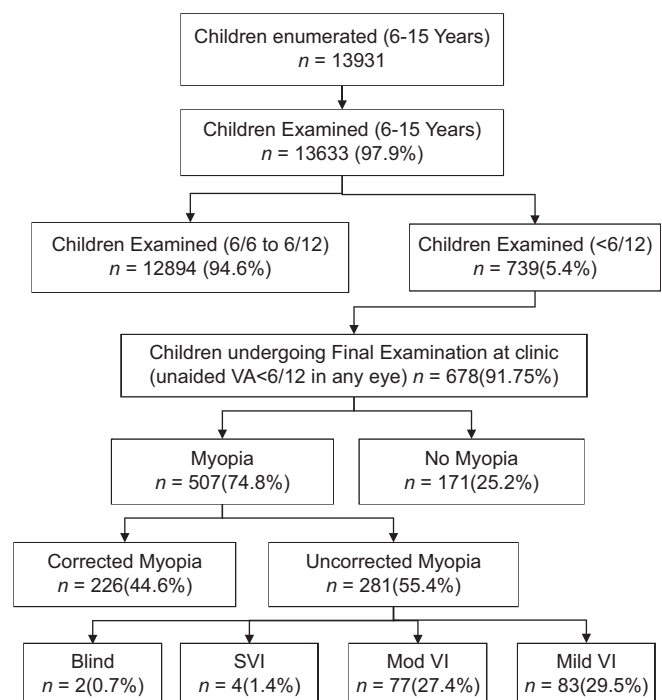


Figure 1: Flow chart summarizing the number of participants at various steps of the study

was 11.6 ± 2.6 years, and their mean myopic refractive error was $-2.8 \text{ DS} \pm 2.7 \text{ DS}$. (median: -2.0 DS ; p25 -3.5 DS , p75 -1.25 DS).

Among these 507 children, 226 (44.6%) were corrected myopia and 281 (55.4%) had uncorrected myopia. Among the children with uncorrected myopia, 82 (29.2%) children had mild visual impairment (presenting visual acuity between 6/12 and 6/19 in better eye) followed by 98 (34.9%) with moderate visual impairment (presenting visual acuity between 6/19 and 6/60 in the better eye), 5 (1.8%) with severe visual impairment (presenting visual acuity between 6/60 and 3/60 in the better eye), and 9 (3.2%) with blindness (presenting visual acuity less than 3/60 in the better eye) [Table 1]. A total of 360 (71.0%) children had low myopia (spherical power between -0.5 and -3.00 DS), 86 (17.0%) had moderate myopia (spherical power between ≤ 3.0 and -5.0 DS), and 61 (12.0%) had high myopia (spherical power $\leq 6.0 \text{ DS}$) [Table 2].

Association of myopia with risk factors

The prevalence of myopia increased with increase in age with prevalence of 6.3% (95% CI: 5.31–7.26) in age group more than 13 years as compared to 1.9% (95% CI: 1.47–2.29) in children aged 6–9 years [Table 3].

The prevalence of myopia also increased significantly with the increasing education with a prevalence of 7.1% (95% CI: 5.86–8.29) in children studying in higher classes as compared to children studying in lower classes (2.4%; 95% CI: 2.02–2.73). There was a higher prevalence of myopia in those children whose parents were wearing glasses (8.2%, 95% CI 6.39–9.97), both in fathers wearing glasses (8.2%, 95% CI: 6.39–9.97) and in mothers wearing glasses (8.6%, 95% CI: 6.62–10.64).

The occurrence of myopia in children aged more than 13 years was higher (OR 2.08, 95% CI: 1.31–3.30) as compared to less than 8 years (OR 1, 95% CI: 1.47–2.28). There was a significant

association between myopia and education in children studying in higher classes ($P < 0.01$) and also between myopic children and parents wearing glasses ($P < 0.001$) [Table 2]. Among the 507 children with myopia, a total of 226 (44.5%) were corrected myopes and 281 (55.5%) were uncorrected myopes [Table 1]. Of these 281 uncorrected myopes, 2 (0.7%) were blind, 4 (1.4%) were suffering from severe visual impairment, and 77 (27.4%) had moderate visual impairment and 83 (29.5%) had mild visual impairment [Fig. 1].

It was observed that the prevalence of myopia was affected by educational status of the child with higher prevalence observed in children studying in higher classes ($P < 0.001$); also, parents wearing distance correction glasses had a significant association with the occurrence of myopia in their children ($P < 0.001$) [Table 3].

Discussion

Myopia is the most common cause of reduced distance visual acuity in children and young adults with its implications on not only education, but also the correction of uncorrected myopia is further associated with its progressive increase, thereby leading to deterioration in daily activities and reduction in quality of life.^[20-29] This is the first cross-sectional, population-based study done in North India to determine the prevalence of visual impairment and myopia among children aged between 6 and 15 years. Though there has been another study done by our center by Murthy *et al.*^[2] a decade ago to determine the prevalence of refractive error in urban children at the community level, it differed from our study as they dilated all the children referred to the clinic with presenting visual acuity $< 6/12$ in either eye.

The prevalence of myopia in our study was 3.7%. On standardization with age and gender, this prevalence with that of children in 6–15 years in East Delhi the prevalence comes out to be 4.8% using the year wise Delhi census population in 6–15 years of age group assuming that population aged 6–15 years form 25% of the total population. This is similar to a community-based study done in Andhra Pradesh in India where they reported myopia to be 4.1%^[3] but is lower than a study done by Murthy *et al.* from our center 10 years ago. Their study reported prevalence of myopia to be 7.4%.^[2] [Table 4] The possible explanation could be that in the present study only children with presenting visual acuity less than 6/12 were dilated with a cycloplegic drug, whereas in the study done by Murthy *et al.*,^[2] all the children with visual acuity less than 6/12 were dilated. The major reason for this difference could be that in this area of east Delhi, the families have migrated mostly from the nearby rural areas of western Uttar Pradesh; therefore, their children are less susceptible to developing myopia as compared to children belonging to urban Delhi. The prevalence of myopia in the present study was less than another community-based study done in Chile^[5] and more than another study done in Nepal (1.2%).^[6,7]

In a recent metaanalysis, conducted by Agarwal *et al.* in Indian school-going children,^[28] the prevalence of myopia in the population-based studies was lower than their counterparts in school-based studies; also, they reported a similar increase in prevalence of myopia in 11–15 years age group. The overall prevalence was 7.5% in 5–15 years of age group.

Table 1: Unaided presenting visual acuity in better eye for children diagnosed with myopia

Vision category (Unaided presenting visual acuity of better eye)	All examined children n (%)	Uncorrected myopia n (%)
BL (< 3/60)	16 (0.1)	9 (3.2)
SVI (< 6/60-3/60)	35 (0.3)	5 (1.8)
ModVI (< 6/19-6/60)	265 (2.0)	98 (34.9)
MildVI (< 6/12-6/19)	168 (1.2)	82 (29.2)
Normal (6/6-6/12)	13088 (96.4)	87 (31.0)
Total	13572 (100.0)	281 (100.0)

Table 2: Distribution of myopia according to severity in children between 6 and 15 years of age

Myopia	n (%)
Low[(-0.5) to (-3.0)]	360 (71.0)
Moderate[(-3.0) to (-5.0)]	86 (17.0)
High $\leq (-6.0)$	61 (12.0)
Total	507 (100.0)

Table 3: Association with myopia with demographic factors: results of multilogistic regression analysis

Category	Myopia (%) n=507	Total n=13572	Prevalence (95% CI)	P	Adjusted OR (95%CI)	P
Gender of Children						
Male	259 (51.1)	7128 (52.5)	3.6 (3.19-4.07)	0.510	1.0	
Female	248 (48.9)	6444 (47.5)	3.9 (3.37-4.31)		1.02 (0.85-1.23)	0.755
Age of Children						
6 to 8 yrs.	80 (15.8)	4256 (31.4)	1.9 (1.47-2.28)	<0.001	1.0	
9 to 11 yrs.	122 (24.5)	4073 (30.0)	3.0 (2.51-3.57)		1.45 (1.06-1.98)	0.018
12 to 13 yrs.	153 (30.2)	2857 (21.0)	5.4 (4.52-6.18)		1.99 (1.33-2.98)	0.001
14 to 15 yrs.	150 (29.6)	2386 (17.6)	6.3 (5.31-7.26)		2.08 (1.31-3.30)	0.002
Education of Children						
Prep/play school	9 (1.8)	703 (5.2)	1.3 (0.44-2.11)	<0.001	1.0	
Primary school	171 (33.7)	7116 (52.4)	2.4 (2.04-2.75)		1.50 (0.75-2.99)	0.248
Middle	205 (40.4)	4029 (29.7)	5.1 (4.40-5.76)		2.23 (1.05-4.70)	0.035
≥9 th standard	122 (24.1)	1724 (12.7)	7.1 (5.86-8.28)		2.83 (1.28-6.29)	0.010
Education of Father						
Primary school	59 (11.6)	2726 (20.1)	2.2 (1.61-2.71)	<0.001	1.0	
Middle	74 (14.6)	2387 (17.6)	3.1 (2.40-3.79)		1.19 (0.83-1.71)	0.320
High school	146 (28.8)	4175 (30.8)	3.5 (2.93-4.05)		1.12 (0.80-1.56)	0.502
Intermediate	129 (25.4)	2780 (20.5)	4.6 (3.85-5.42)		1.33 (0.92-1.94)	0.127
Graduate and above	99 (19.5)	1504 (11.1)	6.6 (5.32-7.83)		1.49 (0.95-2.33)	0.080
Father wearing distance glass						
Yes	74 (14.7)	904 (6.8)	8.2 (6.39-9.97)	<0.001	1.0	
No	429 (85.3)	12378 (93.2)	3.5 (3.14-3.78)		0.60 (0.45-0.79)	<0.001
Education of Mother						
Mother wearing distance glass						
Yes	65 (12.9)	753 (5.6)	8.6 (6.62-10.64)	<0.001	1.0	
No	439 (87.1)	12733 (94.4)	3.5 (3.13-3.76)		0.52 (0.39-0.69)	<0.001
Socioeconomic status of family						
Upper middle (II)/upper	79 (15.6)	1552 (11.4)	5.1 (3.99-6.18)	<0.001	1.0	
Lower middle (III)	214 (42.2)	4511 (33.2)	4.7 (4.12-5.36)		1.18 (0.88-1.59)	0.246
Upper lower (IV)/lower	214 (42.2)	7509 (55.2)	2.9 (2.48-3.23)		0.91 (0.65-1.26)	0.574

Table 4: Prevalence of myopia in various population based studies conducted in India

Author, Year	Study setting, Place of study, type	Prevalence (%)	Study participants	Age of children (yrs)
Murthy <i>et al.</i> , 2002 ^[2]	CB, NI, urban	7.4	5696	5-15
Dandona <i>et al.</i> , 2002 ^[1]	CB, SI, urban	4.1	1810	7-15
Dandona <i>et al.</i> , 2002 ^[3]	CB, SI, rural + urban	3.6	4074	0-15
Trivedi <i>et al.</i> , 2012 ^[5]	CB, WI, rural	4.1	474	7-15

CB – Community based, NI – North India, SI – South India, WI – West India

Conclusion

Though the prevalence of myopia has decreased as compared to previous community-based surveys, this definitely indicates an improvement in refractive error services but as the prevalence is affected by the frequent emigration of the children and their families, along with this, as both corrected and uncorrected refractive errors are almost equal; hence, a further more scope is there for conducting refraction in children to decrease the prevalence of refractive error. The limitations of the study are that though we used the cutoff of 6/12 for referral of children from the household to the central clinic as we conferred to WHO guidelines that recommend refraction in children with unaided visual acuity <6/12.

However, in the school-based vision screening programs, 6/9 is used as a cutoff for refraction as observed in the school-based studies conducted by Saxena^[8] and Kalikivayi *et al.*^[4] In the current study, the children underwent refraction with 6/12 as the referral criteria, so we might have missed some myopia. Hence, another community-based study to determine the prevalence of myopia with a cutoff of 6/9 can be planned in future.

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Conflicts of interest

There are no conflicts of interest.

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