

## PREVALENCE OF REFRACTIVE ERRORS AMONG SECONDARY SCHOOL CHILDREN IN AN URBAN SETUP: A PROSPECTIVE AND OBSERVATIONAL STUDY

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### ABSTRACT

**Objective:** The aim of the study was to determine the prevalence of refractive errors and their types by their age, sex, and class among the students of secondary school in an urban area of state of Punjab, North India.

**Methods:** A cross-sectional study was done on a total of 1545 school children, aged between 10 and 16 years studying in 6<sup>th</sup>-10<sup>th</sup> class. Sample size included 822 males and 723 females. Snellen's distant test types and self-illuminated streak retinoscope were used for this study.

**Results:** Cumulative prevalence of refractive errors was found to be 35.21% among the students. The distribution among the type of refractive errors was: Myopia - 65.07%, Hypermetropia - 14.89%, and Astigmatism - 20.04%. The prevalence among the male and female students was 34.91% and 35.55%, respectively.

**Conclusion:** This study supports the screening of school children for visual acuity and their refractive errors so that they can be identified to improve their quality of life at present and also to prevent any long-term visual disability.

**Keywords:** Prevalence, Refractive errors, Myopia, Hypermetropia, Astigmatism, Urban school children.

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### INTRODUCTION

Refractive errors are one of the most common causes of visual impairment around the world and the second leading cause of treatable blindness [1]. Children of 10-15 years of age constitute 13% of the Indian population. Poor vision in childhood affects performance at school and has negative influence on the future life of the child [2].

Emmetropia can be defined as a state of refraction where in parallel rays of light coming from infinity are focused at the sensitive layer of retina with accommodation being at rest. By the age of 5-7 years, the eye is emmetropic and remains so till the age of about 50 years [3]. Ametropia (a condition of refractive error) is defined as a state of refraction when parallel rays of light coming from infinity, with accommodation at rest, are focused either in front or behind the sensitive layer of retina in one or both the meridians. The term "ametropia" includes: Myopia, hypermetropia, and astigmatism.

Myopia is a dioptric condition of eye in which incident parallel rays come to focus anterior to light sensitive layer of the retina with accommodation at rest. American optometric association (AOA) has defined three grades of myopia: Low myopia when error is  $\leq -3$ D, moderate myopia when error is  $-3$  D- $-6$  D, and high myopia when error is  $\geq -6$ D. Simple or development myopia (a physiological error due to normal biological variation in development of eye) is the most common variety. Since, the sharpest rise occurs at school going age, that is, 8-12 years, so it is also called school myopia. Simple myopia occurs between 5 and 10 years of age and it keeps on increasing till 18-20 years at rate of  $(-0.5 \pm 0.30)$  D every year [3]. Etiology behind myopia can be due to physiological variation in length of the eyeball. Role of diet, genetics, excessive near work in childhood, and limited outdoor activity are some of the proposed theories behind myopia in children.

Hypermetropia is a dioptric condition of the eye in which incident parallel rays come to a focus posterior to light sensitive layer of retina.

AOA defines three grades of hypermetropia as: Low hypermetropia is when error is  $\leq +2$  D, moderate hypermetropia is when error is  $+2$ - $+5$  D, and high hypermetropia is when error is  $\geq +5$  D [3].

Astigmatism is a condition of refraction in which point of light cannot be made to produce a punctate image on the retina by any spherical correcting lens [4]. It is further classified as regular astigmatism and irregular astigmatism.

Sometimes, the total refraction of the two eyes is unequal, the condition is known as anisometropia. Difference up to 5% in retinal images of two eyes is well tolerated. If more than 4 diopter difference exists between two eyes, it is not tolerated. Refractive errors cannot be prevented, but they can be diagnosed by an eye examination and treated with corrective glasses, contact lenses, or refractive surgery. If corrected in time and by eye-care professionals, they do not impede the full development of good visual function [5].

Complications of myopia in long run can be retinal detachment, complicated cataract, vitreous hemorrhage, choroidal hemorrhage, strabismus fixus convergence, and primary open angle glaucoma. Complications, that occur if hypermetropia is not corrected for long time, are accommodative convergent squint, amblyopia, and predisposition to develop primary narrow angle glaucoma. To address the issue of visual impairment in children, the World Health Organization launched a global initiative, "VISION-2020 The Right to Sight." Refractive errors and low vision is one of the main priority component of VISION-2020, along with cataract, trachoma, onchocerciasis, and childhood blindness [6].

The latest global estimate of visual impairment suggests that among children aged 5-15 years, 12.8 million were visually impaired due to refractive errors, representing a prevalence of 0.97%, with higher prevalence reported in China and urban areas of South-east Asia [7]. Symptoms of refractive errors include blurry vision,

headaches, eyestrain, and trouble focusing when reading or looking at a computer, which can be easily ignored by children, so timely screening and intervention are of utmost importance.

## METHODS

A cross-sectional study was conducted at an urban school, Punjab, India. Permission was taken from the Principal of the school. A total of 1545 school children were screened for visual acuity and refractive errors. Students in the age group 10–16 years studying in classes of 6<sup>th</sup>–10<sup>th</sup> were included in the study.

### Exclusion criteria

The following criteria were excluded from the study:

1. Corneal opacity
2. Lenticular opacity
3. Any history of trauma
4. 4 Any history of choroid and retinal disorders
5. Any ocular and associated congenital anomaly

### Inclusion criteria

Only healthy eyes with no organic lesion were taken into consideration.

Visual acuity of total of 1545 students was done to screen for their refractive errors with the Snellen distant test types. Objective refraction was performed in a dimly lighted room using self-illuminated streak retinoscope. As the accommodation is hyperactive in young children and hypermetropes, so a cycloplegic was used for the retinoscopy. Cyclopentolate 1% eye drops were instilled in both eyes after every 10 min for six instillations and retinoscopy was performed after about 60 min of last instillation.

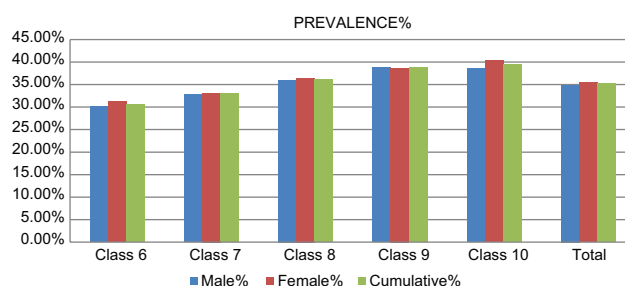
The children were made to sit at a distance of 1 m from the examiner. With the help of a retinoscope, light was thrown into a student's eye who was instructed to look directly into the light and the refraction was assessed along the actual visual axis. Red reflex in pupillary area was observed as retinoscope was moved in horizontal and vertical direction. Results were interpreted as: No movement of red reflex as myopia of 1 diopter(1D), with movement of red reflex as emmetropia or hypermetropia or myopia of <1 D, and against the movement of red reflex as myopia of more than 1 D. In the presence of astigmatism, one meridian was neutralized by adding appropriate cylindrical lens with its axis at the right angle to the meridian to be neutralized. Hence, a rough estimate was made taking into account the retinoscopic findings, that is, deduction for 1 D for distance and 0.75 D for cyclopentolate.

Further analysis of data obtained on the basis of age, sex, class, and type was done.

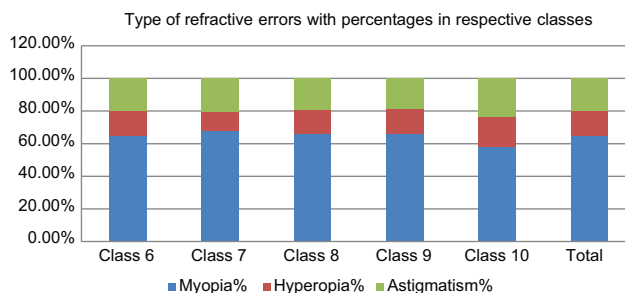
## RESULTS

The cumulative prevalence of refractive errors was 35.21% (n=544/1545). Myopics were the most common [65.07% (n=354/544)] followed by 20.04% with astigmatism (n=109/544) and 14.89% (n=81/544) with hypermetropia. Out of 822 male students, 287(34.91%) and out of 723 female students, 257(35.55%) had the refractive error.

The percentage of refractive error among the male students was 30.11%, 32.80%, 36.02%, 38.79%, and 38.68% of classes 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup>, respectively. The percentage of the refractive error among the female students was 31.18%, 33.11%, 36.49%, 38.71%, and 40.40% of classes 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup>, respectively. The cumulative prevalence was 30.63%, 32.94%, 36.22%, 38.75%, and 39.51% of classes 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup>. The prevalence of refractive errors was seen to increase with increasing age. The prevalence in female students was founded to be slightly higher compared to male students but that was not statistically significant. The detailed analysis of the total number of students affected and their percentages according to gender is shown in table and the bar diagram as given below (Table 1).



Distribution of students (irrespective of their gender) affected with myopia, hypermetropia, and astigmatism according to their number and percentage is given in tables and charts (Table 2).



**Table 1: The prevalence of refractive errors and gender distribution**

Class/Gender	Male	Female	Male%	Female%	Total	Cumulative%
Class 6	53/176	53/170	30.11	31.18	106/346	30.63
Class 7	62/189	50/151	32.80	33.11	112/340	32.94
Class 8	67/186	54/148	36.02	36.49	121/334	36.22
Class 9	64/165	60/155	38.79	38.71	124/320	38.75
Class 10	41/106	40/99	38.68	40.40	81/205	39.51
Total	287/822	257/723	34.91	35.55	544/1545	35.21

**Table 2: Types of refractive errors in absolute numbers and percentages**

Type of error	Myopia	Myopia%	Hyperopia	Hyperopia%	Astigmatism	Astigmatism%
Class 6	69/106	65.09	16/106	15.09	21/106	19.81
Class 7	76/112	67.85	13/112	11.60	23/112	20.53
Class 8	80/121	66.12	18/121	14.88	23/121	19.01
Class 9	82/124	66.13	19/124	15.32	23/124	18.55
Class 10	47/81	58.02	15/81	18.52	19/81	23.46
Total	354/544	65.07	81/544	14.89	109/544	20.04

Visual acuity of the 544 affected students out of the total of 1545 students was noted with Snellen's distant test types. Among them, 106 were from class 6<sup>th</sup>, 112 from class 7<sup>th</sup>, 121 from class 8<sup>th</sup>, 124 from class 9<sup>th</sup>, and 81 from class 10<sup>th</sup>. The trends of visual acuities of students are given in the following tables, both in absolute numbers and percentages (Tables 3 and 4).

## DISCUSSION

In our study, sample size was 1545 students of age group between 10 years and 16 years, among them, 822 were male students and 723 were female students. The cumulative prevalence of refractive errors was 35.21%.

In our study, the prevalence of refractive errors is more; probably due to lifestyle associated with better socioeconomic conditions. In other studies, the prevalence of refractive errors is less. The study by Sethi *et al.* in Ahmedabad, the prevalence of refractive errors was found to be 25.32% [2]. In another study by Ali *et al.* from Lahore on the

prevalence of refractive errors, they found that the children belonging to private schools had 23.3% prevalence [8]. In a study by Monireh Mahjoob *et al.*, overall prevalence of refractive errors among school children was 64.4% [9].

In our study, among the students with refractive errors, 65.07% were myopic, 14.89% were hypermetropic, and 20.04% were with astigmatism. In a study by Nelson *et al.*, increased prevalence of myopia (54.8%) among school children was found, with astigmatism (44%) as second common refractive error [10]. In a similar study by Sethi *et al.*, in Ahmedabad, 63.3% students had myopia, 11.4% had hypermetropia, and 20.4% had astigmatism [2]. Our findings were comparable with these studies.

Mean age of study population in our study was 13.16 years. This was similar to study by Sethi *et al.*, Ahmedabad among school children, in which mean age was 13.22 years [2].

In our study, the prevalence of refractive error is 30.63%, 32.94%, 36.22%, 38.75%, and 39.75% in class 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup>, 9<sup>th</sup>, and 10<sup>th</sup>, which implies that the prevalence increases with age and class. In a similar study by Matta *et al.*, they found that refractive errors increased with increasing age especially in 10–14 years of age [11]. The study by Wu *et al.* concluded that myopia prevalence increased with age [OR: 1.84 (95% CI: 1.75, 1.93); p=0.000] [12].

In our study, the prevalence of refractive errors was only marginally different among male students (34.91%) compared to female students (35.55%). A similar study by Madhu Gupta *et al.* among school children in Shimla found only marginal difference in prevalence among males (52.08%) and females (47.91%) [13]. In a study by Nelson *et al.*, the prevalence of refractive errors was more common among male gender (23.7%) compared to female gender (19.2%) [9]. In a study by Bhutia *et al.*, females had slightly higher refractive error than males [14].

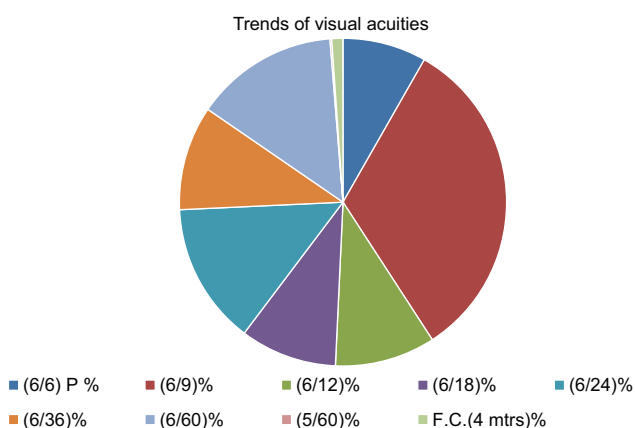
**Table 3: Trends of visual acuities of students in different classes**

Visual acuity	Class 6	Class 7	Class 8	Class 9	Class 10	Total
(6/6) P*	9	5	15	12	4	45
(6/9)	32	46	33	31	35	177
(6/12)	15	15	7	10	7	54
(6/18)	12	12	12	14	2	52
(6/24)	18	11	15	20	12	76
(6/36)	14	10	12	12	8	56
(6/60)	5	11	26	23	12	77
(5/60)	1	0	0	0	0	1
F.C.(4 m)	1	2	1	2	0	6
Total	106	112	121	124	81	544

P\*: Students who could read the last line partially; \*\*Finger counting from 4 m

**Table 4: Trends of visual acuities of students in different classes in percentages**

Visual acuity%	Class 6	Class 7	Class 8	Class 9	Class 10	Total
(6/6) P %	8.49	4.46	12.40	9.68	4.94	8.26
(6/9)%	30.19	41.07	27.27	25	43.32	32.54
(6/12)%	14.15	13.39	5.78	8.06	8.64	9.93
(6/18)%	11.32	10.71	9.92	11.29	2.47	9.56
(6/24)%	16.98	9.82	12.40	16.13	14.81	13.97
(6/36)%	13.21	8.93	9.92	9.68	9.88	10.29
(6/60)%	4.72	9.82	21.49	18.55	14.81	14.15
(5/60)%	0.94	0	0	0	0	0.18
F.C.(4 m)%	0.94	1.79	0.83	1.61	0	1.10
Total%	100.00	100	100	100	100	100.00



## CONCLUSION

This cross-sectional study puts forward refractive error types and their prevalence among secondary school children in an urban area. The cumulative prevalence of refractive errors was 35.21%. The most common refractive error was myopia, followed by astigmatism and hypermetropia.

As the refractive errors are common treatable causes of visual impairment in children, their early detection should be done to give them immediate visual aid to improve their quality of life and to prevent any long-term visual disability.

## AUTHORS CONTRIBUTIONS

RS, SK, HK, and JT conducted research and drafted the manuscript. RS, HK, and JT contributed in identifying refractive errors in students and suggested the necessary correction. RS and SK also contributed in statistics. JT and HK contributed in follow-up and general care. RS and SK revised the manuscript.

All authors read and approved the final manuscript.

## CONFLICT OF INTEREST

We declare that we have no conflict of interest.

## FUNDING AND SPONSORSHIP

Not applicable.

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