

**Original Research Article****Prevalance of color blindness in children**Moudgil T<sup>1</sup>, Arora R<sup>2</sup>, Kaur K<sup>3</sup><sup>1</sup>Dr Tania Moudgil  
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Received: 24-12-2015

Revised: 04-01-2016

Accepted: 01-02-2016

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8054421100**ABSTRACT****Background:** Many people are affected by color blindness but most of them remain undetected as they simply adapt to the environment to certain extent and some remain unaware of the disease.**Objective:** To find out the prevalence rate of color blindness in students of ages 6 years to 15 years, in various schools of Jalandhar.**Methods:** A prospective study was done on 3259 students to identify the prevalence of color blindness. Students were examined with Ishihara Pseudoisochromatic Color Plates 38 edition. If the student was color blind, then it was further classified into its types. The data collected was compiled and analyzed to evaluate the prevalence of color blindness, gender wise prevalence and prevalence of types of color blindness.**Results:** Students of 12 schools were screened in the age group of 6 to 15 years. 3259 students were included in the study; 1683(40.44%) were males and 1584 (59.55%) females. Color blindness was seen in 61 students (1.89%) including 55 (1.69%) males and 6(0.184%) females. Among the color blind 56(91.8 %) were protanopes, 5(8.2 %) were deuteranopes and none were tritanope. Among the protanopes, 52(92.8%) were males and 4 (7.2%) were females and in deuteranopes, percentage of males affected was 4(66.7 %) and

females was 2(33.3%).

**Conclusion:** Color blindness affects males more than females in this study similar to previous studies done. Protonopia is more common than deuteronopia. Early school screening for color vision defect is recommended.**Keywords:** Color blind, deuteranope, prevalence, protanope, trichromatic**Introduction**

Color vision is the ability to discriminate a light stimulus as a function of its wavelength. The description and appreciation of colors depend upon the ability of receptors in retina i.e. rods and cones. Rods are mainly responsible for black and white vision whereas cone systems are mainly responsible for color vision. Colors can be measured and quantified in various ways; indeed, a person's perception of colors is a subjective process whereby the brain responds to the stimuli that are produced when incoming light reacts with the several types of cone cells in the eye. In essence, different people see the same illuminated object or light source in different ways. Light with wavelength between approximately 380

and 760 nm causes photoreaction on human retina, which leads to vision. Various sensory and cognitive processes combine to result in the sense of color.

Color blindness is the commonly used term for deficiency of color vision that is inability to perceive differences between certain colors that a normal person can distinguish. David Brewster introduced the term color blindness, which will be formerly known as daltonism<sup>[1]</sup> after John Dalton, who described in detail his own inability to distinguish red. Color blindness is a common X- linked genetic disorder. However, most of color blinds remain undetected in general population due to absence of proper screening.<sup>[2]</sup> The Ishihara color test is a test to determine if a patient has color blindness. It was named after Dr.

Shinobu Ishihara who first published the test in 1917 as a professor at the University of Tokyo. It is the most widely used screening test for red-green color deficiency.<sup>[3]</sup>

**Impact of color blindness:** Many people are affected by color blindness but many of them remain undetected as they simply adapt to the environment to certain extent and also because of unawareness of the disease.

- Color blind individuals have difficulty in comprehension because of increased reaction time,
- Will only experience a few hundred shades of color, versus those with normal vision that experience millions of shades.
- Learning disability
- unfit for certain jobs like traffic policemen, defence personnel, electrician, electronic engineer, artist which require proper perception of colors which may lead to lesser efficiency in work as well as may cause accident

So it is important to look at the prevalence of color blindness in children and identify the problems associated with it. Keeping the above aspects in mind the following study has been carried out to find out the prevalence of color blindness in school children and to make parents and their teachers aware of this disease so that they can modify their teaching methods and choosing and adjusting with suitable profession.

The present study was done to find prevalence rate and type of color blindness in students of ages 6 years to 15 years and to compare the same in male and female students.

### Material and methods

Subjects included in this prospective study consist of 3259 students of ages 6 years to

15 years, in schools of, Jalandhar by department of ophthalmology, PIMS, Jalandhar after approval of the study by institutional ethical committee .Approval and permission from Principal of schools and informed consents from parents/guardians were taken. Students were called and clinical examination of both eyes was done. Age and sex of the student were noted. The students were tested for color vision deficiency using Ishihara's Type Tests for Color Blindness, 38 Plates Edition. The color vision testing plates was held at 75 cm from the student and tilted at right angle to the line of vision. The test was done in adequate lighted room resembling natural day light. Students were asked to read the numbers seen on the test plates and answer was noted down. The time given for telling the number on a plate was less than 5 sec. Assessment of the reading of the plate determines the normality or defectiveness of color vision and also the type of color blindness. It was interpreted as per the instructions given on the booklet provided with Ishihara's type tests for color blindness so as to identify subject suffering from color blindness and also to differentiate the type of color blindness. The data collected was compiled and analyzed to evaluate the prevalence of color blindness, gender wise distribution and types of color blindness. Microsoft Excel and SPSS ver. 20 will be used to compile data and for appropriate statistical analysis. Chi square test was applied for calculating the p- value

### Results

Twelve schools were screened for studying color vision in school children age group 6 to 15 years. Screening was carried out using Ishihara chart for color vision. Total of 3259 students of 12 schools were screened.

Out of which 1683 were males and 1576 were females (Table: 1) Total 61 students were found to be color blind, out of which 55 were males and 6 were females. Out of 3259, only 61 students were color blind accounting to prevalence of 1.87% color blindness among school children. Among 61 color blind students, males were predominantly affected by color blindness (90.2%) as compared to females (8.8%) with p value <0.01. If we compare among males, out of 1683 males only 55 were color blind (3.3%). Among females, out of 1584 females only 6 were color blind (0.38%). (Fig.1)

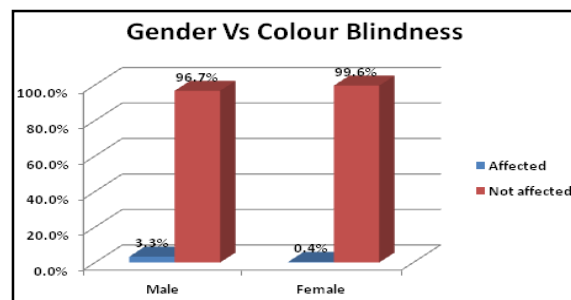


Fig.1

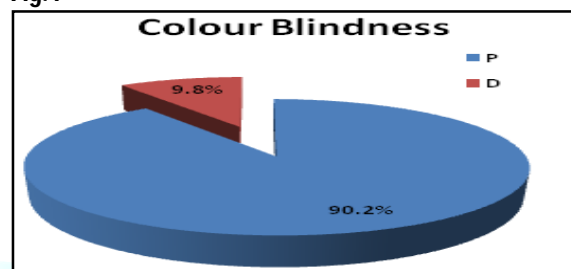


Fig.2

Table: 1 Gender distribution of color blind children

Color Blindness	Gender		Total
	Male	Female	
Affected	55 (3.3%)	6 (0.4%)	61 (1.9%)
Not affected	1628 (96.7%)	1570 (99.6%)	3198 (98.1%)
<b>Total</b>	<b>1683</b>	<b>1576</b>	<b>3259</b>
<b>p-value &lt; 0.01</b>			

Table: 2 Distribution of protanopia and deuteranopia

Color blindness	PROTANOPES		DEUTERANOPES		TOTAL
	M	F	M	F	
<b>N</b>	51(92.7%)	4(7.3%)	4(66.6%)	2(33.3%)	61
<b>TOTAL %</b>	55 (90.2%)		6(9.8%)		100%

Two types of color blindness was seen in our study-protanomaly and deuteranomaly. Protanomaly (90.2%) was more prevalent than deuteranomaly (9.8%) with p-value <0.05. (Fig.2) Protanomaly was observed in 55 students out of 61 color blind students accounting to 90.2% of total color blind students. Among 55 protanopes, 51 were males and 4 were females. Deuteranomaly was observed in 6 students out of 61 color blind students. Among 6 deuteranopes, 4 were males and 2 were females. (Table 2) So among color blinds, protonopia (90.8%) is more

common than deuteranopia (9.2%). In protonopia also males were predominantly effected (92.7%) as compared to females (7.3%).

**Discussion**

Color blindness affects many people and most of the time they are unaware of this trait. Color blind children have certain learning difficulties. Only when they appear for some interview that they undergo ophthalmic check up and come to know that they are suffering from this trait. Specific jobs rely on normal color

perception and hence they get rejected. At that point the person goes through an emotional turmoil. Even day to day life gets affected due to different color perceptions like comprehending the traffic signals. Color blindness is a congenital disease. To study its prevalence in community many studies have been carried out in past. (A comparison of our study with other studies can be seen in Table: 3) In a study, carried out by OP Mahajan and RS Googna<sup>[4]</sup> total 1553 male and 519 female school children of Patiala between the age group of 10 & 15 years were tested for color blindness by Ishihara Charts, Edridge Green Lantern and Pickford Nicolson Anomaloscope. They found 3.85% male and 0.38% female to be color blind. Musa et al<sup>[5]</sup> in their study reported a prevalence of color blindness of 8.72% in boys and 0.33% in girls among young Jordanians. The frequency of red/green color blindness was found to varying between different races, tribes and ethnic groups. The average frequency of red/green color blindness was reported to be about 8% among males and 0.4%-0.7% among females.

Rogositet al<sup>[6]</sup> in their study in cases at age of 15 to 45 years reported a congenital dyschromotopsia frequency of 8.48%. Grassivaroet al<sup>[7]</sup> reported a color blindness frequency of 4.9%. In a population based study of prevalence of Congenital Color deficiencies in Secondary School Students in Tehran, carried out by Modarres M, Mirsamadi M, Peyman GA<sup>[8]</sup>, 2058 secondary school students (1136 males & 922 females) in Tehran were examined with Ishihara Pseudoisochromatic Color Plates and total 97 cases of defective color vision (93 males & 4 females) were detected. Of the 93 cases (8.18%) of defective color vision in male, 56 cases (4.93%) had deuteranomaly,

13 cases (1.14%) protanomaly, 13 cases (1.14%) deuteranopia & 11 cases (0.97%) protanopia. Whereas in 4 cases (0.43%) of defective color vision in female, 3 cases (0.32%) had deuteranomaly and 1 case (0.11%) had protanomaly.

A study conducted by Balasundaram R, Reddy SC, [9] to determine prevalence of color vision deficiency among medical students and health personnel on 1427 health personnel and medical students using 24 plate Ishihara's Test of color vision, found Red Green color vision deficiency in total 45 persons (3.2%) which includes 42 males (6.7%) and 3 females (0.4%). School cohort study screened 1249 children, aged 13-15 years, using Ishihara plate for Red-Green color blindness observed 33 children to be color blind which include 32 boys (5.3%) and 1 girl (0.2%). It also observed, overall 5.4% of Chinese, 4.9% Of Malay and 4.9% Of Indian boys to be color blind. A study by Saumya Agarwal and Nishant Bansod<sup>[10]</sup> was carried out in 595 students (348 boys and 247 girls) from Dr DY Patil Public School, Pimpri, and Pune, to find prevalence of color blindness. Study revealed total 12 students (2.02%) were color blind which include 11 boys (3.16%) and 1 girl (0.40%). Out of 11 boys with color blindness, 10 boys (2.87%) showed deuteranomaly and 1 boy (0.29%) showed protanomaly whereas girl showed deuteranomaly. Prevalence rate for color blindness is found to be higher in males (3.16%) than in females (0.40%). This is true for congenital color blindness. In which red-green color blindness is the common most defect which is inherited as X-Chromosome –linked recessive. As male have only one X-chromosome, they are prone to suffer from the defect while females are mainly carrier. Citiriket et al, <sup>[11]</sup> in their study from Turkey reported a red-green color blindness

overall prevalence of 7.33%. (Table: 3)

Table: 3 Comparison with other studies

S No.	Name of the study	Prevalence of color blindness
1.	OP Mahajan and RS Googna	found 3.85% male and 0.38% female to be color blind.
2.	Musa et al	reported a prevalence of color blindness of 8.72% in boys and 0.33% in girls among young Jordanians
3	Rogosic et al	congenital dyschromotopsia frequency of 8.48%
4	Grassivaro et al	reported a color blindness frequency of 4.9%.
5	Modarres M, Mirsamadi M, Peyman GA	Reported total 97 cases of defective color vision (93 males & 4 females) were detected. Of the 93 cases (8.18%) of defective color vision in male, 56 cases (4.93%) had deuteranomaly, 13 cases (1.14%) protanomaly, 13 cases (1.14%) deuteranopia & 11 cases (0.97%) protanopia. Whereas in 4 cases (0.43%) of defective color vision in female, 3 cases (0.32%) had deuteranomaly and 1 case (0.11%) had protanomaly.
6	Balasundaram R, Reddy S C	found Red Green color vision deficiency in total 45 persons(3.2%) which includes 42 males(6.7%) and 3 females (0.4%).
7	Saumya Agarwal and Nishant Bansod	Study revealed total 12 students (2.02%) were color blind which include 11 boys (3.16%) and 1 girl (0.40%). Out of 11 boys with color blindness, 10 boys (2.87%) showed deuteranomaly and 1 boy (0.29%) showed protanomaly whereas girl showed deuteranomaly. Prevalence rate for color blindness is found to be higher in males (3.16%) than in females (0.40%).
8	Çıtırık et al	reported a red-green color blindness overall prevalence of 7.33% in Turkey
9	Mohd Fareed et al	observed that the prevalence of CVD ranged from 5.26% to 11.36% among males and 1.15%–3.03% among female children of six populations. The average prevalence of CVD was 7.52% observed in males and 0.83% in female children in Jammu province.
10	B Dakshayani and M R Gangadhar	Reported percentage frequency of red green color blindness was 1.12% in Hakkipikkis of Mysore district of Karnataka state
11	Present study	prevalence of color blindness in our sample was 1.89% which include 1.69% males and 0.184% females. It was observed that out of the color blinds 90.2 % were protanopes and 9.8 % were deuteranopes. Among the protanopes, 92.7% were males and 7.3% were females and in deuteranopes percentage of males affected was 66.7 % and females was 33.3%. Males were affected more with the disease than females with a p value <0.01 making it highly significant.

Osuobeni<sup>[12]</sup> in his study that included Arabian children reported the prevalence of red- green color blindness as 2.9%. Mohd Fareed et al<sup>[13]</sup> conducted a study in

Jammu province and observed that the prevalence of CVD ranged from 5.26% to 11.36% among males and 1.15%–3.03% among female children of six populations.

The average prevalence of CVD was 7.52% observed in males and 0.83% in female children. Male children tend to have higher CVD frequency which reinforces the fact of X-linked recessive nature of the trait (i.e., the single X-chromosome in males is predominant to color blindness, while females with two X-chromosomes can act as dosage compensation and decreases the risk of the disease). The frequency of red-green color blindness among the males of Libya (2.2%), Saudi Arabia (2.9%), Nepal (3.9%), Singapore (5.3%), Thailand (5.6%), Korea (5.9%), Turkey (7.3%), Iran (8.1%), Jordan (8.7%), and Eastern India (8.73%) were found higher than that among females.<sup>[14-18]</sup>

B Dakshayani and M R Gangadhar carried out a study of red green color blindness among the Hakkipikkis of Mysore district of Karnataka state and reported that the percentage frequency of red green color blindness was 1.12%.<sup>[19]</sup>

In our study, it was found that prevalence of color blindness in our sample was 1.89% (Table 1) which include 1.69% males and 0.184% females. It was observed that out of the color blinds 90.2 % were protanopes and 9.8 % were deuteronopes (Table 2). Among the protanopes, 92.7% were males and 7.3% were females and in deuteronopes percentage of males affected was 66.7 % and females was 33.3%. Our study was more or less in accordance of previous studies. Males were effected more with the disease than females with a p value <0.01 making it highly significant.

Color blindness is disease which affects mostly males. Our study affirmed the same with overall prevalence of 1.89% out of which 90.2% being males and protanopia (91.8%) was observed most commonly. So it is very important that school children should be screened for color blindness and chose their career later on wisely.

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**Cite this article as: Moudgil T, Arora R, Kaur K. Prevalence of color blindness in children. *Int J Med and Dent Sci* 2016;5(2):1252-1258. Source of Support: Nil Conflict of Interest: No**