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# Colour vision abnormalities among medical students

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## Abstract

**Introduction:** This study was conducted to analyse the colour vision abnormalities among medical students.

**Materials and Method:** In this cross-sectional study, 225 undergraduate medical students in the age group of 19-25 years (21.54±1.40)were screened for colour vision deficiency using Ishihara's Pseudoisochromatic chart 24 plate edition. Students with defective colour vision were identified and further classified according to its types. The data collected was entered and analysed using SAS 9.2, SPSS 15, Stata 10.1, MedCalc 9.0.1, Systat 12.0 and R environment ver.2.11.1.

**Results:** After careful screening it was noted that, out of the 225 students, colour blindness was seen in 7 students(3%) including 6 males and 1 female. Among them, Deuteranomaly was detected in 4 males and Protanomaly in 2 male students and 1 female student.

**Conclusion**: Present study shows higher prevalence of colour blindness in males than females which is similar to the previous studies done. CVD commonly remains undetected and hence students of health sciences must be screened for colour vision deficiency and made aware of their defect, so that they can take special care in clinical practice.

**Keywords:** Colour blindness, Deutranomaly, Ishihara plate, Medical students, Protanomaly

## Introduction

Colour blindness, also known as colour vision deficiency, is defined as an inability to discriminate certain colours; which is due to the inability to discriminate a light stimulus as a function of its wavelength. It affects approximately 8% of men and 0.4% of females worldwide. A recent study from Eastern India has reported 8.73% of males and 1.69% of females as colour blind.(1)

The photosensitive cells in the retina called cones help in description and appreciation of colours. Young Helmholtz's theory postulates the existence of three kinds of cones i.e. red, blue and green sensitive which synchronously perform the function of colour vision. Each type of cone possess a different photo-pigment that is maximally sensitive to one of the 3 Primary colours. The cone photoreceptors are S-short wavelength sensitive (415 nm), M- medium wavelength sensitive (530nm), L- long wavelength sensitive (560nm). These constitute the primary colours GANONGD effects in colour vision results from absence, malfunction or alteration of one, two or all the photo pigments. When only one of the pigments is affected, they are called Dichromats and when 2 pigments are affected they are called Monochromats. Achromats are the ones without any photo pigments.

Dichromatism characterized by entire absence of green cones are called Deuteranopia, while those characterized by entire absence of red cones are called Protanopia and those characterized by absence of blue cones are called Tritanopia. Anomalous trichromacy is relatively mild form of defective vision. The terms protanomaly, deuteronomaly and tritanomaly is given when there is defect in red, green and blue pigments respectively.(2) Achromatopsia is an extremely rare condition presenting as cone monochromatism or rod monochromatism.

Colour vision abnormalities can be either hereditary or acquired. Impaired colour vision in case of red-green colour blindness is genetically determined by X-linked recessive inheritance, where males are affected and females are carriers. The prevalence of congenital red-green colour blindness in Asian males is around 5%.(3) Acquired colour blindness may occur as a secondary feature to pathology and can arise at any time throughout life as a result of general or ocular diseases (those affecting the macula or optic nerve),trauma or drug toxicity.

Many people are affected by colour blindness, but they often remain undetected because of the unawareness of the disease, possibly due to adaptation. So screening for colour deficiencies specially among medical professionals is important as it may become difficult for them in interpreting coloured clinical signs like pallor, icterus, cyanosis, etc. especially when subtle. Also, certain sub specialties in medicine require colour- based interpretations like Colour Doppler, laboratory investigations, etc. This study was mainly undertaken in order to detect the colour deficient individuals among the cohort of medical students to have an ideal about the prevalence. It also meant to create awareness in them about their Colour vision deficiency and a to provide appropriate advise which might help them in choosing an appropriate carrier in future.

## Materials and Method

The study was carried out among the medical students of Sri Siddhartha medical college from September 2016 to December 2016.

This cross-sectional study was conducted among 225 undergraduate medical students aged between 19-25 years. The study was approved by the Institutional Ethics Committee and informed written consent was taken. After obtaining the consent from the students, their systemic random sampling was done and primary demographic data was noted. Students were also asked to fill a questionnaire which included questions regarding the presence of any ocular diseases, any history of recent head injury and presence of any systemic diseases and intake of chronic medications.

All the students underwent Visual acuity testing – distance & near, Colour vision testing –using Ishihara's Pseudo-Isochromatic Chart 24 Edition. The test was conducted binocularly. Uni-ocular re cording was done whenever required. The chart consists of printed figures which are intentionally made of colours that are liable to look the same as the background to an individual who is colour deficient. Examination was conducted in class rooms or demonstration rooms of Ophthalmology OPD consisting of wider windows with adequate bright light. All recordings were done in day light only, no artificial lighting was used. The plates were held at arm's length from the subject and tilted at right angle to line of vision. The students were shown the first 17 plates of the Ishihara chart. They were instructed to identify the number on the test plates as soon as possible (average duration of 2-3 seconds per each test plate).

Plate 1- Introduction Plate; Plate 2-15- transformation plates used for screening red-green deficiencies and Plate 16 and 17 are used for protan and deutran defects.

If 13 or more plates are read normally, colour vision is regarded as normal. If only less than 9 plates are read normally the colour vision is considered defective. Colour deficit individuals are immediately re-tested for confirmation and subjected to refraction and correction, Slit lamp biomicroscopy, and fundus examination ensure that no other ocular abnormality was present.

## Results

A total of 225 undergraduate medical students were enrolled in the study. Participants age ranged between 19-25 years with the mean ± Standard deviation of 21.54 ± 1.40.(Table 1, Fig. 1)

**Table 1: Age distribution of patients studied**

| Age in years | No. of patients | % |
|---|---|---|
| <20 | 7 | 3.1 |
| 20-25 | 218 | 96.9 |
| Total | 225 | 100.0 |

Mean ± SD: 21.54±1.40

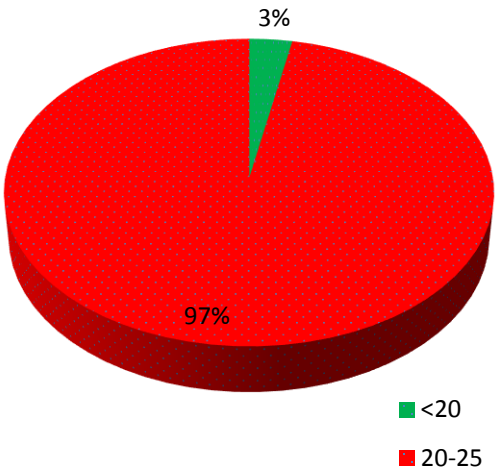


**Fig. 1**

112 were males and 113 were females. There was no significant difference in baseline gender discrimination.(Table 2, Fig. 2)

**Table 2: Gender distribution of patients studied**

| Gender | No. of patients | % |
|---|---|---|
| Female | 113 | 50.2 |
| Male | 112 | 49.8 |
| Total | 225 | 100.0 |

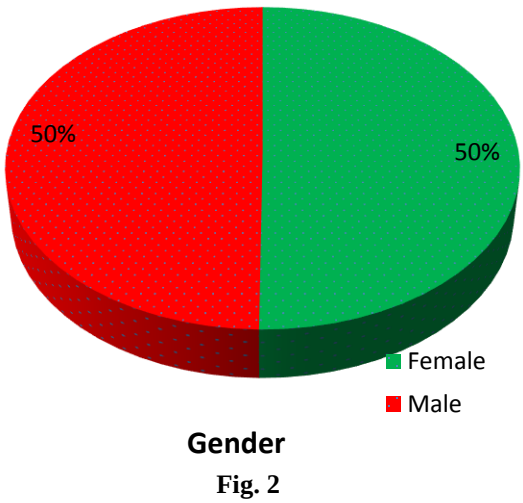


**Fig. 2**

A total of 7 students were found to be colour blind accounting for a prevalence of 3%.

Of the 7 students, 6 were males and 1 was female. All the 7 participants identified the numeral in the first plate, but read a different number in the transformation

plates (2-15) as compared to the normal individuals.(Table 3, Fig. 3)

**Table 3: Gender distribution of patients studied**

| Gender | Anomaly | | Total |
|---|---|---|---|
| | Normal | Abnormal | |
| Female | 112(51.4%) | 1(14.3%) | 113(50.2%) |
| Male | 106(48.6%) | 6(85.7%) | 112(49.8%) |
| Total | 218(100%) | 7(100%) | 225(100%) |

P=0.050*, Significant, Chi-Square test

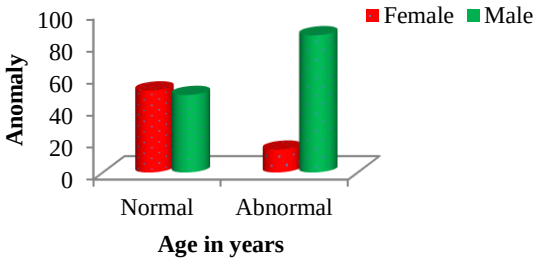


**Fig. 3**

Two types of colour blindness was noted in our study based on the classification Plates (Plates 16 & 17) - Protanomaly and Deuteranomaly. Deuteranomaly was found in 4 males and Protanomaly in 2 males and 1 female student (Table 4, Fig. 4).

**Table 4: Type of Anomaly distribution of patients studied**

| Type of Anomaly | Gender | | Total (n=225) |
|---|---|---|---|
| | Female (n=113) | Male (n=112) | |
| Normal | 112(99.1%) | 106(94.6%) | 218(96.9%) |
| Abnormal | 1(0.9%) | 6(5.4%) | 7(3.1%) |
| Deutronomaly | 0(0%) | 4(3.6%) | 4(1.8%) |
| Protonomaly | 1(0.9%) | 2(1.8%) | 3(1.3%) |

P=0.050*, Significant, Chi-Square test

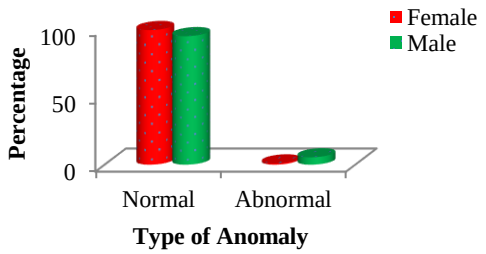


**Fig. 4**

None of the colour blind individuals were aware of their defect.

## Discussion

Colour blindness is a common disorder but it often goes unnoticed as the individual adapts himself to the environment to a certain extent and also because of the unawareness of the disease.[4] The most common colour vision defects are the protan and deutan defects. So screening tests identify only red-green deficiencies and screening of colour vision deficiencies is usually done with Ishihara chart. It was named after Dr. Shinobu Ishihara who first published the test in 1917 as a professor at the University of Tokyo.

The studies conducted by Dain SJ et al[5] and Birch J[6] showed that the sensitivity of Ishihara test was 96% and mean specificity is 98.5% and there was no evidence that Ishihara's test was less valid than any other screening tests .In this study we used Ishihara's test 24 plate edition which is effective in detecting red-green defects.

The prevalence of red-green deficiency varies between human population of different racial origin. It is about 8% for Caucasian males, 5% for Asian males and 4% for African males. The prevalence of colour blindness in general population in South India, which was 2.4%.[7]

A study conducted by Balasundaram R, Reddy SC,[8] to determine prevalence of colour vision deficiency among medical students and health care professionals on 1427 medical students and health care personnel using Ishihara 24 plate Edition revealed red-green deficiency in 45 persons(3.2%) which includes 42 males (6.7%) and 3 females (0.4%).

Pramanik T, Khatiwada B and Pandit R[9] conducted a study to determine the colour vision deficiency among the 215 students of Nepal medical college. Among them 12 were colour blind(5.5%). 1 was totally colour blind, protanomaly was detected in 1, deutranomaly was detected in 3 and deutranopia in 7 volunteers.

A study was carried out by Moudgil et al[10] on Prevalence of colour blindness in school children aged 6-15years.A total of 3529 students of 12 schools were screened using Ishihara chart. The study revealed that 61 students were colour blind, out of which 55 were males(90.2%) and 6 were females(8.8%). It was also found that Protanopia(90.8%) was more common than deutranopia(9.2%)

Our study shows the prevalence of colour blindness of 3% in medical students which is more or less in accordance with the previous studies. It was also observed that the frequency of colour blindness is slightly higher in males (5.6%) than females(0.8%) with the p value=0.05 making it significant. Deutranomaly was seen in 4 males. Protanomaly was seen in 2 males and 1 female.

Colour blindness is present in males if the X-chromosome has the abnormal gene. Females manifest a colour defect only if both X chromosomes contain the abnormal gene. Daughters of a male with X- linked

colour blindness are carriers and 50% of the sons inherit it. In this way, X- linked colour blindness affects males of every 2nd generation. Transient colour weakness for blue- green is reported as a side effect of Sildenafil. Visual cortex lesions can also cause Achromatopsia,(11) a fact that must be borne in mind.

## Conclusion

Thus in our study it was affirmed that colour blindness is a disease which most commonly affects males than females. So it is suggested that medicals students especially males should be screened for colour vision deficiency so that they may be given proper counseling in choosing their career in future. We also recommend further studies to be done in order to determine the severity and pattern of colour vision defects using anamaloscope and FM 100 hue test.

## Conflict of Interest

Conflict of interest declared none.

## Limitations of this Study

- Limited study population
- Ishihara's chart was used for detecting the colour vision deficits, while the gold standard in colour vision test is Anamaloscope.

## References


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