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Prevalence and pattern of colour vision defect among healthy medical and paramedical students in Gwalior, India

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ABSTRACT: Purpose: To determine the prevalence and pattern of colour vision defect among healthy medical and paramedical studentsof age group 18-25 years. **Method**: A prospective observational study was conducted after obtaining approval from ethical committee in a tertiary care eye center, Gwalior, India from January 2019 to June 2020. 500 healthy medical and paramedical students of age group 18-25 years were screened for colour vision defect using Ishihara Chart 38 plates 10th edition. Then those who were found colour vision defective were further evaluated for types of CVD using Edridge Green Lantern test.**Result**: Overall prevalence of colour blindness was found to be in 3.2% students. Male predominance was found with 6% prevalence in males and 0.4% prevalence in females. Among 16 students with colour vision defect in our study, 93.8% students were males and 6.3% students were females. Protanomaly was present in 0.6 % students, Protanopia in 0.2 % student, Deuteranomaly in 1.4 % students, Deuteranopia in 0.6 % students and Tritanomaly in 0.4 % students. **Conclusion**: High proportion of the population is unaware of their colour vision status.Early detection of colour vision defects in children play an important role in necessary life adjustments and appropriate learning leading to the better career choices.

KEYWORDS: Colour vision defect, Ishihara chart, Edridge Green Lantern, Colour vision screening.

I. INTRODUCTION:

An accurate colour vision plays an important role in individual's understanding of the visual world and performing day to day life activities with perfection. Individuals with colour vision defects (CVD) can experience difficulties in everyday life [1].

Medical professionals with CVD may potentially have some difficulties in training and practice in medicine; detecting colour changes in human body, skin rashes, erythema, bile or blood in urine, sputum, vomit. They face difficulties in interpretation of colour slides, test strips, specimens. Ophthalmologists also have difficulties while doing ophthalmoscopy, reading OCT & Pentacam charts and interpreting colour sensitive monitors.[2-4] However, there are limited evidence regarding the real impact of CVD on the practice of medical professionals.

The colour vision defects have a high prevalence throughout the world and reported prevalence of the CVD is about 8% in males and 0.4% in females worldwide.[5] Various studies from India have documented prevalence rates of 2%–4% on average although rates have varied from 1% to 8% across studies.High proportion of the population is unaware of their colour vision status as their vision is otherwise normal.

Various testing techniques has been introduced for colour vision assessment, among which Anomaloscope is considered to be the gold standard diagnostic tool.[19] Colour vision testing is an integral part of ophthalmology examination for various occupations for instance pilots, loco pilots, armed forces, to safeguard colour deficient individual as well as vulnerable population. The Ishihara test is the most widely accepted test specific for screening the congenital colour defects.[20] Edridge Green Lantern(EGL) test is the technique incorporated for conducting medical examination of the candidates applying for recruitment into government services in Gazette of India[21]. EGL is the most frequently used vocational test worldwide.

II. METHOD:

After obtaining approval from ethical committee 500 healthy medical and paramedical students of age group 18-25 years were screened for colour vision defect in tertiary care eye center, Gwalior, India from January 2019 to June 2020 in the after taking informed and written consent from patients. Mean agewith SD for male students was 22.22 ± 2.33 years and for female students was 21.17 ± 1.86 years in our study.Only Healthy subjects with best corrected vision 6/6 and in each

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eye and without any systemic and ocular pathology were included.

History was taken to rule out the factors that can affect colour vision like any significant ocular or systemic diseases. A detailed history of any prolonged intake of drug affecting color vision defect like ethambutol, chloroquine, barbiturates, phenytoin or digoxin were elicited. Any positive family history of colour vision defect was also recorded. Complete systemic examination was done. Ophthalmic examination of anterior and posterior segment was done according to the proforma to rule out glaucoma, macular degeneration and retinitis pigmentosa.

All candidates were evaluated for the color vision defect using Ishihara Pseudoisochromatic chart 38 plates 10th edition. Candidates were asked to hold the book at 75 cm with the plates perpendicular to the visual line under daylight illumination. For each plate 4 seconds were provided to read it and identify the pattern.The plates were given in a random order to avoid answers by memorization. Those candidates who were found to be defective on Ishihara were evaluated further using the Edridge Green lantern test. The lantern consists of 5 rotating discs each with eight apertures Disc 1 has different aperture sizes, while Discs 2, 3 and 4 contain filters with eight colours: one white, two reds, two greens, yellow, blue and purple.The test was performed at a distance of 6 meter in a dark room. The candidates were asked to identify various colours through 4 different apertures. An exposure time of 5 seconds for identification of colour was provided for every slide. Person with normal colour vision was seated beside the students as control for the test. The record was made for colours identified/not identified through four different aperture size. Candidates who described the colour as a different shades of colour were considered as anomalous trichromatic and candidates who were completely unable to identify the colour in any aperture and described the colour as whitewere considered as dichromatic.The results of these two tests were compared in terms of colour vision normal, colour vision defective and type of colour vision defect. Statistical analysis was done by one-way ANOVA test and unpaired t-test, using IBM SPSS statistics version 20.0 package. A p-value <0.05 denoted a level of significance.

III. RESULTS:

On screening all 500 students with Ishihara chart test, 16 students were found to be coulour vision defective accounting for overall prevalence rate of CVD as 3.2% in our study. Among 250 male students. 15 had CVD with the prevalence rate of 6.0%. Among female students one female had CVD with prevalence rate of 0.4% Statistically significant (p=0.0001) higher prevalence of CVD in males than females was found in our study.(Table 1)

Colour Vision	Gender		Total	χ^2, P Value
	Male	Female		
Affected	15	1	16	12.65, p=0.0001*
Total subject	250	250	500	
Prevalence	6.0%	0.4%	3.2%	

Table 1: Gender wise distribution of CVD

On Edridge Green Lantern test, Protanomaly was found in 0.6 %(n=3) students, Protanopia in 0.2 %(n=1) students, Deuteranomaly in 1.4 %(n=7) students, Deuteranopia in 0.6 %(n=3) students and tritanomaly in 0.4 %(n=2) students. None of the students were found to have tritanopia or monochromatism.(Figure 1)

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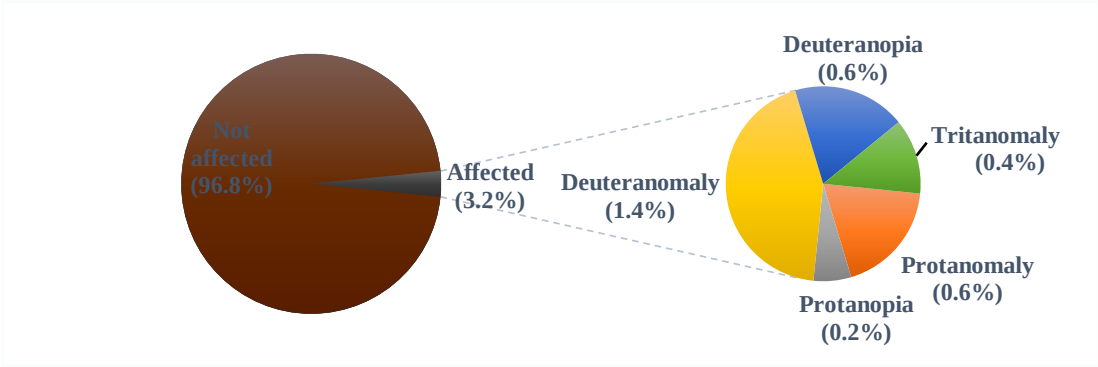

Figure 1: Distribution types of CVD

In our study, among 250 males, Protanomaly was present in 1.2% (n=3) males, Protanopia in 0.4% (n=1) males, Deuteranomaly in 2.4%(n=6) males, Deuteranopia in 1.2%(n=3) males and Tritanomaly was present in 0.8%(n=2) males. None of the males were found to be affected with Tritanopia or Monochromatism. Among 250 females, Deuteranomaly was present in 0.4% (n=1) females. None of the females were found to be affected with Protanomaly, Protanopia, Deuteranopia, Tritanomaly, Tritanopia or monochromatism.(Table 2)

Colour Blindness	Male No. (%)	Female No. (%)	Total
Protanomaly	3 (1.2%)	0 (0.0%)	3
Protanopia	1 (0.4%)	0 (0.0%)	1
Deuteranomaly	**6 (2.4%)**	**1 (0.4%)**	7
Deuteranopia	3 (1.2%)	0 (0.0%)	3
Tritanomaly	2 (0.8%)	0 (0.0%)	2
Tritanopia	0 (0.0%)	0 (0.0%)	0
Monochromatism	0(0.0%)	0(0.0%)	0
Total	15 (6.0%)	1 (0.4%)	16

Table 2: Gender wise distribution of types of CVD

IV. DISCUSSION:

Colour vision defectoften goes unnoticed as the individuals can adapt himself to the environment to a certain extent, most of the individuals are unaware of the their colour vision status.[22] Prevalence of congenital colour vision defect varies among the different population, race and sex with a higher preponderance in males.[18]Studies among school children in American and Asian populationsreported prevalence rate of 3.1–6.2%.[23-25] An average prevalence of 8% is reported in studies worldwide.[26-28] The ratio of protans to deutans was noted to be 1:3.Various studies in past have reported this ratio to range from 1:2 to 1:10 6[29,30]

On Ishihara chart test, Overall prevalence rate of CVD was found to be 3.2% in our study. This is comparable with the prevalence rate of 3.16% to 3.7% reported by various other studies conducted in India [31,32]Similar overall prevalence of 3.0% was documented by **Sandhya R. et al**.[33], prevalence of 3.2% by **Balasundaram R et al** among 1427 medical students and health care personnel,[34] similar overall prevalence of 2.8 % by **Krishna Swami Mehra**.[35]Lower overall prevalence of 1.80% as compared to our study, was

documented by **Jigna R. Patel et al**.[36] This difference could be attributed to ethnicity difference. **Rajan Pandit et al** documented prevalence of 2.33%.[37] Prevalence of 2.1% by **Neha R. Chandak et al,**[38] Prevalence of 1.77% by **Osama Abdulqadir Khairoalsindi et al.**[39] **Poornima Basavaraj et al**[40] and **Alla Venkata Pitchi Reddy et al**[41] also documented lower overall prevalence of 1.4% and 1.9% respectively. prevalence of 1.6% was documented by **Temesgen Tola Geletu et al**[42] . **Siddiqui QA et al** also documented lower prevalence rate of CVD as 2.75%. [31]

The prevalence rate among males in our study was found to be 6% that is low as compared to 8% prevalence in males worldwide that can be attributed to ethnicity differences. We found a statistically significant association between CVD and gender as more males had CVD than females (P = 0.0001). Male gender predominance in CVD has been documented in our study as compared with other studies.The prevalence among females was found to be 0.4% that is comparable with the 0.4% prevalence in females worldwide.

Higher prevalence of 5.6% in males as compared to our data but lower rate than data worldwide was documented by **Sandhya R. et al** with prevalence females 0.8% with significant p value = 0.05.[33] **Masarat Nazeer et al** documented higher prevalence of 7.14% in males and in females prevalence of 0.68% as compared to our study[43] **Arpan Chakrabarti et al** documented similar prevalence in males as 6.37% males and higher prevalence in females as 2.03% as documented by our study.[44]Lower prevalence of 1.60% in males and 0.20% in females was documented by **Jigna Ratilal Patel et al,**[36] prevalence of 4.66 % among males and 0% among females by **Rajan Pandit et al,**[37] prevalence 3.61% among males and higher prevalence as 1.05% in Females by **Krishna Swami Mehra**,[35]

Our study has documented Protanomaly in 0.6 % students, Protanopia in 0.2 %, Deuteranomaly in 1.4 %, Deuteranopia in 0.6 % and Tritanomaly in 0.4 % on EGL test. None of the students were found to have Tritanopia or Monochromatism. Deuteranomaly was found to be the commonest CVD type in our study followed by Protanomaly and Deuteranopia that is comparable with the worldwide data. Pattern of CVD documented in our study is comparable with pattern documented by **Masarat Nazeer et al** in their study.[43] They also found Deuteranomaly as the most common type of CVD in 1.33% followed by Protanomaly 1.0% then Protanopia 0.6% and Deuteranopia 0.6%. **Osama Abdulqadir Khairoalsindi et al** The Deuteran CVD was found in 1.59% students and Tritan CVD in 0.17% students.[39] **Poornima Basavaraj et al** documented 1.2% students were protanopes, 0.2% students were deuteranopes and none of them were tritanope.[40]**Alla Venkata Pitchi Reddy et al** Among the colour blind 90.3% were protanopes, 9.7% were deuteranopes and none were tritanope. Among the protanopes, 92.8% were males and 7.2% were females and in deuteranopes, percentage of males affected was 66.6% and females was 33.3%.[41]

In our study, among 250 males, Protanomaly was present in 1.2% (n=3) males, Protanopia in 0.4% (n=1) males, Deuteranomaly in 2.4%(n=6) males, Deuteranopia in 1.2%(n=3) males and Tritanomaly was present in 0.8%(n=2) males. None of the males were found to be affected with Tritanopia or Monochromatism. Among 250 females, Deuteranomaly was present in 0.4% (n=1) females. None of the females were found to be affected with Protanomaly, Protanopia, Deuteranopia, Tritanomaly, Tritanopia or monochromatism.**Arpan Chakrabarti et al** documented the similar trend of pattern of CVD, Deuteranomaly as the most common defect among males as well as females. They found, 0.76% were Trichromatic and 2.9% were Dichromatic among males. Protanomaly was present in 0.87%, deutranomaly in 2.6%, Protanopia in 1.76% and Deuteranopia in 1.16%.[44]Among females, 1.27% were Trichromatic and 0.76% were Dichromatic. Protanomaly was present in 0.51%, deutranomaly in 0.76%, Protanopia in 0.25% and Deuteranopia in 0.51%.**Sandhya R. et al** documented Deuteranomaly in 1.77% males. Protanomaly in 0.8% males and 0.4% in female.[33]**Neha R. Chandak et al** documented deuteranomaly as the most common defect among males. Among males with CVD, protans were 1.1% and deutans were 2.5%. Among females with CVD, protans and deutans were 0.2% each.[38]

V. CONCLUSION

Our study concluded that Prevalence of CVD among medical and paramedical profession is 3.2% as in general population. High proportion of the population is unaware of their colour vision status as their vision is otherwise normal.Deuteranomaly was found to be the commonest CVD type in our study followed by Protanomaly and Deuteranopia that is comparable with the worldwide data. Screening of all entrants to medical and paramedical profession should be done for early detection of defect as they are unlikely to have been screened at earlier stages in India. Those who found defective on CVD screening should be

tested further to determine nature and severity and should be properly advised regarding career choices in medicine. Spreading awareness about the nature and severity of their CVD and proper counselling will mitigate adverse impact of CVD and will help medical professionals to successfully adapt to their defect and in implementation of good medical practices.

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