Assessment of color vision among undergraduate medical students

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Abstract

Introduction: Color vision deficiency is an under-reported problem among medical personnel, and its impact is still not well characterized. Many people with colour blindness remain undetected either they adapt to the environment or unaware of the disease. Color is often used as an important sign in medical practice as many descriptive and diagnostic terms like jaundice, cyanosis, pallor and erythema are used. It is also used while doing colour coding for many new technologies and procedure. Thus, the present study aims to evaluate the prevalence of colour blindness among undergraduate medical students of KIST Medical College and Teaching Hospital.

Methods: A descriptive cross- sectional study was conducted among all the MBBS students until 2025 from 1st January to 15th April 2025 after obtaining ethical approval from Institutional Review Committee (Reference number: 2081/82/19). The study was conducted at a single institution. The assessment of color blindness was done with the help of Ishihara chart. All the collected data were compiled and analyzed using Excel.

Results: The prevalence of colour blindness was 2.62% (12/458). All affected individuals were male, yielding a male specific prevalence of 4.59% (12/261). No cases were detected in females (0/197). Among the colour blind, four (33.33%), three (25%), two (16.66%), two (16.66%) and 1 (8.33%) males were found to have deuteranopia, total colour blindness, deuteranomaly, protanomaly and protanopia respectively.

Conclusion: Color vision is crucial for medical students because it enables them to accurately diagnose and treat various conditions. Therefore, routine screening for colour vision deficiency is recommended for medical students to ensure patient safety and guide career choices.

Keywords: Colour vision, Ishihara chart, Medical students

Introduction

Human retina contains photoreceptors; rods and cones, which are responsible for night vision, day vision and colour vision respectively. Human color vision is the mixture of red, green and blue lights.[1] Colors are perceived by cones and signals are generated which are mixed by the brain and create wide spectrum of colour we perceive.[2] Among the various types of the diseases that are inherited, color blindness is a comparatively common occurrence of the ophthalmological diseases.

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The inability to differentiate the colors is named as color blindness. The affected individuals have disability with learning and identification of the colors.[3,4] Most of the color vision deficiency (CVD) are congenital but seldom it may be acquired as well. The four types of CVD are protan (red), duetan (green), tritan (blue), and achromatopsia (total absence of colour vision).[5,6] The most common is the red-green color blindness. Among common population in the world, color blindness affects approximately 8% in males and less than 1% in females.[4,7,8]

Color vision is used in various medical procedures, including interpreting physical signs, analyzing bodily fluids, and identifying histopathological specimens. Undiagnosed CVD among medical students may lead to difficulty in recognizing clinical signs that depend on colour. Students may underperform in practical exams that require recognition of colour clues. It is crucial for medical students and future healthcare professionals because it impacts their ability to accurately diagnose and treat patients. Thus, the present study was conducted to find out the prevalence and types of color vision deficiency among undergraduate MBBS students of KIST Medical College and Teaching Hospital.

Methods

A descriptive cross-sectional study was conducted from 1st January 2025 to 15th April 2025 among all MBBS students from first to fifth year until 2025 of KIST Medical College and Teaching Hospital, Imadol, Lalitpur after obtaining IRC approval (Ref. no. 2081/82/19) and informed consent prior to the study. Students who submitted incomplete data forms and those who were not willing to take part were excluded from the study. Convenience sampling was used. Sample size was calculated by using the following formula,

$n = Z^2 \times p \times q / e^2$

$n = (1.96)^2 \times 0.0233 \times 0.9767 / (0.02)^2$

$n = 218$

n= minimum required sample size

Z= 1.96 at 95% Confidence Interval (CI)

p= prevalence is taken as 2.33% [9] for maximum sample size calculation

q= 1-p

e= margin of error, 2%

The calculated sample size was 218. A total of 458 students were enrolled, exceeding the minimum required sample size and enhancing the study power. The assessment of colour blindness was done with the help of Ishihara Chart (Ishihara's test for colour deficiency 38 plates, latest edition by Shinobu Ishihara, Professor Emeritus of the University of Tokyo, Member of Japan Academy). This chart consists of polychromatic plates containing printed figures made up of colored spots on a background of similarly shaped colored spots. The figures are intentionally made up of colors that are liable to look the same as the background to an individual who is color deficit. Each participant was asked to sit in adequately lit room and to read all the colored plates of ishihara chart. The chart was held 75cm away from the subjects. Time allocated to identify the number on the test plate was 3 seconds. The students were asked to read the numbers seen in test plates 1 to 17. Recognition of plates 1 to 15 determines the normality or defectiveness of colour vision. If 13 or more plates were read correctly, the colour vision was considered as normal otherwise the individual will be recorded as color vision deficiency person. The diagnostic plate no. 22 to plate no. 25 was used to find out the protanomalous (defective red colour appreciation), deuteranomalous (defective green colour appreciation), protanopia (complete red colour defect) deuteranopia (complete defect for green colour). The person with total colour blindness and weakness could only read the number plate of 1.10 Data collection was meticulously done by the faculties of the ophthalmology and physiology department of KIST Medical College and Teaching Hospital. For those who were positive in the first attempt were given a repeated test for confirmation. The types of colour vision defects were noted and differentiated by principal author with the help of key provided with the chart. Descriptive statistical methods (frequency and percentage) were used to statistically analyzed the data by using Excel.

Results

In the present study, 458 undergraduate MBBS students (261 males and 197 females) were assessed for colour blindness. The gender distribution of the study population is shown in figure 1.

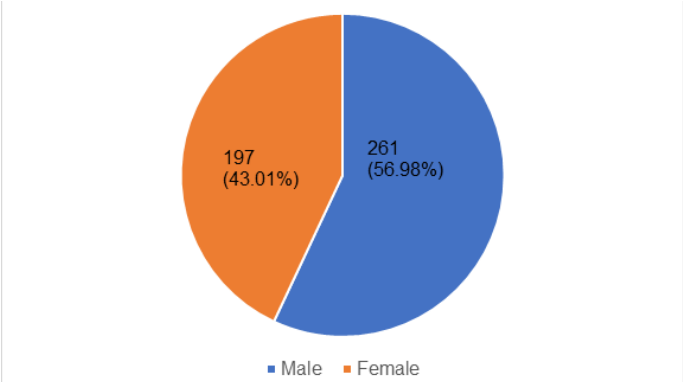


Figure 1: Gender distribution of the total students (n= 458)

Among 261 boys, 12 were found to have colour vision defects with prevalence of 4.59% however none of the girls were found to have colour blindness. (Table 1)

Table 1: Prevalence rate of colour blindness among the genders

Genders	Frequency (n)	Colour vision defects (n)	Percentage (%)
Male	261	12	4.59
Female	197	0	0
Total	458	12	2.62

Among the male participants, the commonest type of colour vision defect was deuteranopia accounted for 4 (33.33%) followed by total colour blindness in 3 (25%) and deuteranomaly in 2 (16.66%) (Table 2)

Table 2: Distribution of various types of colour vision defects (Male, n = 261)

Type of CVD	Frequency (n)	Percentage (%)
Deuteranopia	4	33.33
Total colour blindness	3	25
Deuteranomaly	2	16.66
Protanomaly	2	16.66
Protanopia	1	8.33
Total	12	100

Out of 12, colour vision defect male respondents, Chhetri and Brahmin were the predominant ethnic groups, comprising 33.33% and 25% respectively as presented in Table 3. (n=12)

Ethnicity	Frequency (n)	Percentage (%)
Chettri	4	33.33
Brahmin	3	25
Madhesi	2	16.66
Others	2	16.66
Newar	1	8.33
Total	12	100

Discussion

In this study, the prevalence of color blindness among the boys were found to be similar to other studies.[4,7,9]However the frequency of color blindness (male) in our present study higher than that of Shrestha 3.3%,[10], Niraula 3.8%,[11] India 2.3%.[12] Color blindness is an inherited problem thus the genes responsible for the most common forms of color blindness are located on the X chromosome. As females have two X chromosome, a defect in one is typically compensated by the other, while males have only one X chromosome. They are commonly suffered.[13] None of the girls in our study had color blindness which makes our study similar with studies in India,[14]Nepal.[15] In contrast to our study, many studies have reported presence of color deficiency among female students.[6,13,16,17] This could be due to the common practices of consanguineous marriage in that part of the world. However, other reason may be that our studies reported only congenital color blindness and where as other reported acquired and congenital color vision deficiency which could lead to different results.

In the present study, by Ishihara chart the most common type of colour vision defects were deuteranopia accounting for 4 (33.33%) followed by total colour blindness in 3 (25%) , deuteranomaly in 2 (16.66%),protanomaly in 2 (16.66%) and protanopia in 1 (8.33%).This finding is consistent with the study conducted among health science students in Kathmandu.[9] In contrast to this study, other studies have revealed deuteranomaly as a commonest type of color blindness.[10,18] Red-Green defects (Protan and Deutan) show the highest prevalence in the general population. The cause of Protan and Deutan defects is by recessive mutations of the genes located on the long arm of X- chromosome with Xq 28 band.[2] The finding of our study is different from the study done by Hashemi H et al. where tritanopia was the most common type of color blindness.[13]

The studies have found that the frequency of red-green color blindness varies between different races, tribes and ethnic groups.[15] In our study, Chhetri and Brahmin were the predominant ethnic groups, comprising 33.33% and 25% which was similar to other studies.[15,19,20] The different results in ethnic- wise distribution of color vision defects might be because of the different ethnic sample size in different studies.

As a limitation, we included a small number of population and enrolled only one institute, hence we cannot generalize the result. We used Ishihara test for determining colour vision defects which is quick and easy but it has limited ability to classify color blindness and its severity. The recommended method to grade and classify color blindness is to use Fransworth Panel D15 or Fransworth -Munsell 100-hue tests.[21]However, this is not available with us.

The findings underscore the importance of mandatory colour vision screening for all medical students upon entry. This allows for early awareness, appropriate counselling regarding specialty choices, and the implementation of strategies to mitigate potential risks in clinical practice, thereby enhancing patient safety.

Conclusion

Higher occurrence of color blindness in male suggests that the prevalence is gender specific. Moreover, the students were unaware about their condition. Color vision is essential for tasks like interpreting blood tests, examining tissues under a microscope, and identifying skin lesions. Many medical disciplines rely on color to identify diseases, such as pathology, radiology and dermatology. Furthermore, medical students must be aware of their own color vision deficiencies to make informed choices about their future career paths and ensure patient safety.

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