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Prevalence of Color Vision Defect in Bachelor of Dental Surgery Students at Kathmandu Medical College

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ABSTRACT

Introduction: Color vision plays a vital role in prosthodontics and aesthetic dentistry, where accurate shade matching is essential for achieving optimal restorative outcomes. Color vision deficiency (CVD), a hereditary or acquired disorder that impairs the perception of certain colors, can affect the diagnostic and restorative performance of dental practitioners. Early screening among dental students can help identify individuals with CVD and reduce the risk of clinical errors. The aim of study was to determine the prevalence of color vision defects among Bachelor of Dental Surgery (BDS) students at Kathmandu Medical College Teaching Hospital (KMCTH).

Methods: A cross-sectional observational study was conducted among BDS students from the first year to internship between April and September 2023. Ethical approval was obtained from the KMC Institutional Review Committee (Ref no: 21032023/05), and informed consent was obtained from all participants. A total of 376 students (98 males and 278 females) were examined using the 24-plate Ishihara Pseudoisochromatic Test. Data were entered into Microsoft Excel and analyzed using SPSS software.

Results: Of the 376 participants, 17 students (4.52%) were identified with color vision defects. Among them, 13 (3.46%) were males, and 4 (1.06%) were females. Two male students were found to be completely color-blind. Most affected individuals showed mild to moderate CVD, misidentifying one or more Ishihara plates.

Conclusion: The prevalence of color vision deficiency among BDS students at KMCTH was **4.52%**, with a higher occurrence among males. Regular color vision screening is recommended for dental students and practitioners to identify those with CVD and to ensure accurate color matching and high-quality aesthetic outcomes.

Keywords: Color Vision Deficiency, Ishihara Test, Shade Matching, Prosthodontics.

INTRODUCTION

The sensitivity of the retina to wavelengths in the range of 400 to 700 nm from the entire electromagnetic spectrum underlies the psychophysical phenomenon of vision. Color is a feature of organoleptic that is used to identify certain molecules in particle and bulk forms[1]. Red, green, and blue are the fundamental colors seen by cones, and all other colors are perceived as mixtures of the three primary colors. Color blindness: a human disorder, makes a human lose the ability to see one of the following three colors: red, blue, green, or a color resulting from mixing together. Situations where the person cannot see colors at all are very rare. The inability to perceive some specific colors is a sign of color vision deficiency (CVD)[2].

CVD can be genetic or acquired.[3] It causes difficulties in everyday life and the source of

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light the object and observer are all impacting factors in color recognition[4]. The different types of color blindness are Monochromacy, Dichromacy and anomalous trichomacy[5]. In prosthodontics, restorative and aesthetic dentistry, color vision is a crucial component[6]. In contrast to dental parameter, several medical conditions are identified by analyzing the changes in color such as the color changes seen in oral mucosa in different lesions.

There are numerous techniques used today to evaluate tooth color, from visual subjective comparison using paper, colored porcelain, or acrylic resin shade guides to instrumental objective measurements utilizing spectrophotometers, colorimeters, and image processing techniques. Team-based approaches to shade matching can assist a CVD dentist in making a more accurate shade choice if the dentist is aware of his or her limitation. Dental students should be aware of any color deficiencies they may have when practicing dentistry. Additionally, it was deemed necessary to at least screen dental staff members to identify any potential color deficiencies that they may have, as this could result in incorrect shade matching and the need to redo their job[7]. CVD in a subject is detected and its severity is analyzed by means of several tests, viz, Ishihara Pseudochromatic Test, Lantern Test and Anomaloscope test[2].

The objective of the present study was to determine the prevalence of Color Vision Defect (CVD) in Bachelor of Dental Surgery (BDS) students of Kathmandu Medical College

METHODS

This descriptive cross-sectional study was conducted at the Department of Dentistry, Kathmandu Medical College Teaching Hospital (KMCTH), from April to September 2023, to assess the prevalence of color vision deficiency (CVD) among Bachelor of Dental Surgery (BDS) students. Ethical approval for the study was obtained from the KMC Institutional Review Committee (Reference number: 21032023/05), and informed consent was obtained from all participants before data collection.

The study population consisted of all BDS students from first year to internship enrolled at KMCTH, as these students are routinely involved in shade matching during prosthodontic and restorative procedures and in the diagnosis of intraoral soft- and hard-tissue lesions. A convenience sampling technique was used. The sample size was calculated based on a 4% prevalence of CVD reported by Malhotra et al.[8] among medical and nursing students at the Institute of Medicine, Tribhuvan University. Since the total number of BDS students at KMCTH was 376, all eligible students were invited to participate voluntarily, yielding a final sample of 376 participants. Students with a history of ocular disease, ocular trauma, or systemic illness affecting vision, as well as those unwilling to participate, were excluded.

Color vision assessment was performed using the 24-plate Ishihara Pseudoisochromatic Test following the standard protocol described by Dr. Shinobu Ishihara.[9] Each student was tested individually under natural daylight by presenting the plates at a distance of approximately 75 cm and perpendicular to the visual axis, and responses were recorded within three seconds. Participants were categorized as having normal color vision if all plates were identified correctly, as having color vision defect if one or more plates were incorrectly identified, and as color-blind if none of the plates were correctly identified. All data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS, version 21). Descriptive statistics, including frequencies and percentages, were used to determine the prevalence and distribution of CVD among male and female participants.

RESULTS

This study was conducted among the BDS students from the first year to the internship at the Kathmandu Medical College. Altogether 376 students, 98 (26.06%) were male and 278 (73.94%) were females. Furthermore, 17 (4.52%) of the total students were presented with color vision defect. Among those who presented with color vision defect, 13 (3.46%) were male students and 4 (1.06%) were female students. The present study also found that 15 students presented with one or more plate color vision defects and 2 students were considered color blind (Table 1).

DISCUSSION

Color blindness, also known as color vision deficiency (CVD), is a condition that affects an individual's ability to perceive colors accurately and is one of the common genetic disorders observed. In the context of Nepal, the study among the school-going students conducted by Shrestha et al.[10] reported 3.90% male students in Kathmandu Valley had color vision defects. Another Kaski-based study conducted by Niroula and Saha reported a prevalence of 3.8% color vision defect in male students[11]. None of the girls were found with deficient vision in both studies.

Pramanik et al. conducted another study among the students of health sciences in Nepal and found that 12 (5.58% of the study population) were color-deficient, and among them, one student is totally color blind[7].

Jha et al. conducted the study among the undergraduate students of Nepal and found that 24 (2.9%) of their study sample had color vision defects, and all were males, and 14 (58.3%) of those who were diagnosed with CVD were found to be totally color blind[12]. A study done by Khatri et al. found 13 (17.8%) patients with the color vision defect, where 12 were male, and one was female[13].

Mohatara and Shrestha conducted a study among medical and nursing staff of Nepal and gave similar reports to most of the earlier studies, with the male population having more CVD than females. They found that 20 (6.6% of their total male sample) were color vision deficient, while only 2 (0.8% of the female sample) were found to be color vision deficient[8]. The color vision does not cause any severe disability, and the condition persists from birth of the affected individual, whose experience of the color is totally different from that of a normal individual.

The study conducted in India by Naik and Pai shows 4% of the study population had CVD, with no females reported, while Chaudahri et

Table 1: Distribution of Participants Based on Ishihara Plate Identification and Shade-Matching Ability

Ishihara Test Result (Number of Plates Correctly Identified)	Number of Participants (n)	Correct Shade Matching (Male/Female)	Interpretation
All plates correct	359	85 / 274	*Normal vision*
1 plate incorrect	9	7/ 2	*Color vision deficiency*
2 plates incorrect	4	3 / 1	*Color vision deficiency*
3 plates incorrect	2	1 / 1	*Color vision deficiency*
0 plates identified	2	2 / 0	*Color blind*

al. reported 2.2% of males and 1.1% of females with CVD[14]. Khalid et al.[15] conducted a study in Pakistan; 9 (3.75%) students were found out to be color blind, among whom 7 (7.95%) were male, and 2 (1.39%) were female, respectively. Al Aqtum study also shows a higher frequency among males (8.72% male and 0.33% female) [16]. Jaju et al.[17] conducted a study to determine the color-matching ability of the dental students and found 3.9% of the total students who were enrolled in the study were color blind.

Davison and Myslinski study found that 5.54% of their study population (Students and faculty) have color-defective vision. Color-defective dental students and dentists made significantly more errors in shade selection than those with normal vision, and errors were specifically in the hue and chroma. This study also determined that dental assistants are significantly more accurate than color-defective personnel in shade selection[18].

Problems in learning, education, and work performance may arise due to CVD. A study conducted by Khosla et al.[6] among the dental professionals also found 19% of their study population as a color vision deficient (17 males and 2 females). The two female operators having color vision deficiency gave an underlying medical history of being on systemic steroids. Wasson and Schuman proposed (as cited by Khosla et al.[6]) three alternative tracks for the individuals who tested positive for color vision defect: (a) a formal course in colour education and training for dentists and dental assistants, (b) the development of a staff trained in color matching discrimination of teeth shades, and (c) development of colorimetric instruments. The alternative tracks are adjunctive measures that will provide a cohesive clinical practice environment for the dental clinician. The ability to match the shade of porcelain fused to metal, partial denture and implant retained restoration to that of natural teeth is an important goal of restorative dentistry.

Studies conducted by Fayez[19] (5% male and 1% female) in Saudi Arabia, Ebrahim et al.[4] (male 14.4% and female 12.2%) in Iran, and Toukhy et al.[20] (male 4.5% and female 0%) in an Egyptian study also found that males are more affected by CVD than females. A study done by Bamise et al.[21] among the Nigerian dental practitioners conflicted with most of the studies; CVD was more prevalent in women (9.3%) compared to men, 4.8%. Suliman et al.[3] found 5.6% of the male study population had CVD, but no females were detected with color vision defects. This study also shows that there was no significant difference in the score of the shade matching test between participants with CVD and participants with normal color vision ($p=0.075$). Problems in learning, education, and work performance may arise due to CVD. Screening of dental students, dentists, and dental professionals is recommended for CVDs so that they are aware of their problems and hence overcome them by adopting alternative ways to avoid any errors while working on patients. Most of the studies that were reviewed during this study period found that the male population is more affected by the color vision defect than the female population.

This study was limited by its single institution setting and the use of a convenience sampling method, which may affect the generalizability of the findings. Additionally, color vision was assessed using only the Ishihara test, which does not differentiate the type or severity of color vision deficiency.

CONCLUSION

Color vision deficiency, although present in a small proportion of dental students, can influence essential clinical tasks such as shade matching and lesion identification. In the present study, color vision defects were observed in 17 students, with a higher

prevalence among male (13; 3.46%) compared to female (4; 1.06%). Among those affected, 15 students demonstrated one or more plate color vision defects, while 2 students both males were identified as color blind. Regular color vision screening is therefore recommended to ensure early identification of students or practitioners with CVD. When identified, a team-based approach should be adopted to support affected individuals, ensuring accurate clinical decision-making and maintenance of high quality patient care.

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