

Prevalence and Awareness of Congenital Color Vision Deficiency among Medicine and Health Science Students at Wolkite University: Implications for Clinical Training.

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Abstract

Background Color vision deficiency affects the ability to distinguish colors, which has implications for health professionals. However, many are unaware of its existence and potential impact. This study aims to determine the prevalence and level of awareness of congenital color vision deficiency among health science students at Wolkite University, Ethiopia.

Methods A cross-sectional study was conducted among medical and health sciences students at Wolkite University from July 10 to 29, 2022. Socio-demographic data were collected using a structured questionnaire. Visual acuity was measured, and color vision testing was performed using the Ishihara pseudo-isochromatic 38-plate edition. Data were analyzed using SPSS version 20 software.

Result The study involved 425 participants, of whom 64.0% were male, with a mean age of 21.6 years (± 1.5). The prevalence of color vision deficiency (CCDD) was 1.9%. A statistically significant association was found between sex and CVD status ($p = 0.032$). Among the affected students, 87.5% had deutan deficiency and 12.5% had protan deficiency. None of the affected participants were aware of their color vision problem.

Conclusion Health science students should be screened for color vision deficiency to improve their awareness and enable them to make informed decisions about their future careers, preventing patient mismanagement. [*Ethiop. J. Health Dev.* 2026; 40(1)]

Keywords: Prevalence, Colour vision deficiency, Awareness, Health science students, Ethiopia

Introduction

Color vision deficiency (CVD) is the absence or reduced ability to distinguish between colors under normal illumination conditions (1). Each type of color vision impairment is caused by gene rearrangements, deletions, or mutations that encode the appropriate L, M, or S photopigment (2,3). The most prevalent type, known as hereditary red-green recessive deficiency, is inherited as an X linked recessive pattern. These are permanent, nonpathological disorders that do not worsen over time or impair other aspects of visual function. Conversely acquired red-green recessive deficits are primarily caused by ocular and cerebral diseases, usually affecting only one eye and progressing according to the underlying cause (2, 3).

Congenital color vision deficiency (CCVD) affects approximately 8% of men and 0.5% of women globally (4). Men are most affected by the X-linked inheritance pattern, while women become carriers of the defective gene (4). Research carried out in Ethiopian schools across several regions has yielded varied findings, ranging from 1.6 % to 4.2 % (5,6). Published evidence indicates that CCVD appears to be just as common in the medical community and related fields as it is in the general population (7). For individuals with CCVD, daily activities such as cooking, interior design, sports, and clothing shopping have been found to pose difficulties (8). Similarly, color vision deficits have been noted to present challenges for healthcare professionals across various areas of medical practice (7). Research has shown repeatedly a significant proportion of people with CCVD, including health care professionals, are unaware of the condition's existence and severity (8).

Although color vision is required for different professions, delaying screening until after making career decisions can lead to professional disappointment (1,8). Individuals with CVD are better able to manage their patients and choose their profession when they are aware of their color vision status. To the best of our knowledge, no CCVD study has yet been conducted in Ethiopia among health science students or medical practitioners. Therefore the purpose of this study was to assess the prevalence and awareness of CCVD among health science students at Wolkite University.

Subjects and Methods

Study population and study design

A descriptive cross-sectional study was conducted from July 1 to July 30, 2022, at Wolkite University's College of Medicine and Health Sciences in southern Ethiopia. The study aimed to determine the prevalence and awareness of CCVD among students of medicine and other health sciences. Located 178 kilometers southwest of Addis Ababa, Wolkite University is a state-run institution. The university admits students from various regions across the nation, as allocated by the Ministry of Education. At the time of the study, the college was training 1,164 undergraduate students across six departments: Public Health, Nursing, Midwifery, Pharmacy, Medical Laboratory Science, and Medicine.

Sampling technique

The study included every student at the College of Health Sciences, with the exception of the midwife students who were not present on campus at the time of the study period. Exclusion criteria included a history

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of ocular trauma, ocular disease, prior ocular surgery, long-term medication use, or being born to non-Ethiopian parents.

The sample size was determined using a single population proportion formula with the following parameters: a 4.2% prevalence from a previous study in Northwest Ethiopia (6), a 95% confidence interval (CI), a 2% margin of error, and a 10% non-response rate. Consequently, the final sample size was calculated to be 425.

$$n = \frac{Z^2 P (1-P)}{d^2}$$

Study participants were selected using the multistage sampling approach. The registrar's office supplied the student rosters, and the sample size was divided proportionally across the five fields. From each discipline, classes were selected at random using a lottery method. A sampling fraction was then calculated for each selected class. The first participant was chosen via lottery, and subsequent participants were selected at regular intervals based on the sampling fraction (systematic sampling of every fifth student).

Data collection tool and procedures

Data were collected through face-to-face interviews and clinical examinations conducted by the principal investigator, a senior ophthalmology resident. A structured questionnaire was used to gather socio-demographic and clinical information, including age, sex, ethnicity, religion, department, prior history of eye disease, long-term medication use, previous color vision testing and awareness of CVD.

All subjects underwent visual acuity (VA) assessment. The VA was tested at a distance of six meters using Snellen chart under monocular viewing in day light

hours. Color vision was evaluated using the 38-plate edition of Ishihara's pseudoisochromatic plates.

Before testing, each subject received a comprehensive explanation of the procedure. Testing was performed in a dedicated space with sufficient natural light. The plates were positioned 70 cm from the subject and tilted so that the plane of the paper was perpendicular to the line of vision. Participants were allotted three seconds to identify the numbers on each plate. Results were classified according to the criteria established in the Ishihara test manual (9). Participants identified with CCVD subsequently underwent a comprehensive ocular examination by the principal investigator to rule out any underlying ocular diseases.

Data analysis

The data was coded, cleaned, and checked for accuracy in EPI INFO version 7 before being exported to SPSS. SPSS version 26 was used for doing the statistical analysis. Descriptive statistics were utilized to present the sociodemographic data of the study participants, using frequencies and percentages. The Chi-square (χ^2) test was used to determine the statistical significance; a P-value of less than 0.05 was considered as statistically significant.

Results

A total of 425 students, with 100% response rate, participated in the study. Their age ranges from 19-28 years, with a mean (\pm standard deviation) of 21.6 (\pm 1.5) years. There were 272 (64%) men and 153 (36%) women. Participants in the study were from eleven distinct ethnic groups. Of these, 34.1% were from the medical field. Students studying nursing, medical laboratory science, public health, and pharmacy make up 25.4%, 17.9%, 12.2%, and 10.4% of the total. The results of CCVD among the participants are displayed in Table 1.

Table 1: Socio-demographic variables and CCVD IN health science students Wolkite University, South Ethiopia, 2022, N=425

Variables		Color vision status		Total	P-value
		Normal (%)	CVD (%)		
Sex	Male	264 (97.1)	8 (2.9)	272 (64.0)	<0.005
	Female	153 (100)	0	153 (36.0)	
	Total	417 (98.1)	8 (1.9)	425 (100)	
Religion	Christian	324(97.9)	7(2.1)	331 (77.9)	0.35
	Muslim	89(98.9)	1(1.1)	90 (21.2)	
	Waaqeffanna	4(100)	0	4 (0.9)	
	Total	417 (98.1)	8 (1.89)	425 (100)	
Ethnicity	Amhara	126 (98.4)	2 (1.6)	128(30.1)	
	Oromo	117 (98.3)	2 (1.7)	119(28)	
	Gurage	102 (98.1)	2 (1.9)	104(24.5)	
	Silte	18 (94.7)	1 (5.3)	19(4.5)	
	Hadiya	14 (93.3)	1 (6.7)	15(3.5)	
	Welayta	14 (100)	0	14(3.3)	
	Sidama	14 (100)	0	14(3.3)	
	Tigray	8 (100)	0	8 (1.9)	
	Others *	4 (100)	0	4(0.9)	
	Total	417 (98.1)	8 (1.9)	425 (100)	

In the male population, the prevalence of CCVD was 1.9% (95% (CI): 1.69-2.13), All identified cases occurred in male participants, accounting for 2.9% of the male cohort. No female participants were found to have CCVD.

The association between CCVD and male sex was statistically significant ($p = 0.032$); however, no other variables in this study showed a significant correlation with the condition (Table 2).

Regarding the type of deficiency, one participant (12.5%) was identified as protan (red color deficient), and seven (87.5%) were identified as deutan (green color deficient). No students were

found to have a total lack of color vision (achromatopsia). CCVD was present among participants from five ethnic groups: two Gurage, two Amhara, one Silt'e, and one Hadiya student exhibited deutan deficiency, while one Oromo student exhibited protan deficiency.

Notably, none of the participants with CCVD had previously undergone color vision testing, and all were unaware of their condition prior to this study. Furthermore, every student identified with CCVD presented with normal results during their comprehensive ocular examination.

Table 2 Correlation between CCVD in health science students of Wolkite University, South Ethiopia, 2022 (N=425)

Variables	p-value	Chi-Square
Age	0.40	0.7
Sex	0.03	4.58
Religion	0.93	1.4
Ethnicity	0.95	3.9

level of significance ($p < 0.05$)

Discussion

Color is often used as a descriptive and diagnostic indicator in clinical practice. Healthcare professionals with color vision impairments reported a range of challenges. The most frequent ones included changes in body color (pallor, cyanosis,

jaundice, rashes, and erythema of the skin), test strips for blood and urine; ophthalmoscopy; otoscopy and tissue identification during surgery (10). Medical students with CCVD encounter many of the same obstacles as practicing clinicians (11). Among the benefits of screening are that it helps the

student and, subsequently, the doctor, identify gaps in their observational skills and come up with solutions, allowing them to make an informed professional decisions.

Although the anomaloscope is considered the gold standard for identifying and categorizing CCVD, it is an impractical screening tool due to its high cost, significant size, and lack of portability. In contrast, the Ishihara test is the most widely utilized screening tool; it is affordable, easy to administer, and demonstrates high sensitivity and specificity in detecting red-green color vision deficiencies (12).

The prevalence of CCVD is 1.9% in this study, which is similar to the prevalence rates of 1.6% and

1.8% in school-age children in eastern and central Ethiopia, respectively (13, 5). Our findings also align with research on medical students in Cameroon (1.7%) and Nigeria (1.7%) (14,15). However, compared to the 2.1% prevalence rates among Saudi Arabian medical students (16) and the 2.23% prevalence rates in Nepal (17), the results of this study are lower. Table 3 provides a summary of the prevalence of CCVD in a few studies among individuals of different ages, races, and ethnicities in contrast to the findings of this study. Variations in CCVD prevalence may be caused by a variety of factors, including different populations, geographic areas, racial and cultural origins, and methods for evaluating color vision (4).

Table 3 Characteristics of CCVD reported compared with our study finding

	Year	Study area	Testing method	Total Prevalence (%) (95% CI)	Male Prevalence (%)	Female Prevalence (%)
AFRIC						
Ours	2022	Central Ethiopia	Ishihara	1.9(1.69-2.19)	2.9	0
Nwobodo E ¹⁴	2022	Nigeria	Ishihara	1.7	2.34	1.23
Ramadan EA ¹⁹	2021	Egypt	Ishihara	3	6.9	0.5
Dohovoma VA ¹⁵	2018	Cameroun	Ishihara-Roth's 28	1.3	2.58	0
Reta ⁸	2020	Ethiopia	Ishihara	2.85	3.75(3.05-4.45)	0.68
Mengistu ⁶	2018	Ethiopia	Ishihara	4.24	3.18	1.06
Temesgen ¹³	2018	Ethiopia	Ishihara	1.6	3	0.2
Mashinge ²⁴	2019	South Africa	CVTME**	2.2(0.9-3.1)	4.2(3.1-6.4)	0.6(0.1-1.1)
ASIA/MIDDLEEAST						
Nazeer ²⁰	2019	India	Ishihara	4.16	7.14	0.68
Pandit R ²⁵	2018	Nepal	Ishihara	2.33	4.66	0
Bhatti SA ²⁶	2021	Pakistan	Ishihara	2	3.23	0
Pramanik ²³	2012	Nepal	Ishihara	-	5.58	-
Alamoudi ¹⁶	2021	Saudi Arabia	Ishihara	2.1	4.31%	0
Europe						
Harrington ²¹	2020	Ireland	RHRR	5.3(4.3-6.5)	8.3	1.8
NR*= Not Reported						
**CVTME=Color vision testing made easy						
*** RHRR= Richmond Hardy-Rand Rittler test						

The 2.9% prevalence of CVD among male participants in our study is similar to studies on male medical students done in Nigeria (2.3%) and Sudan (4.0%), (14, 22). However less than Saudi Arabia's (4.31%) and Nepal's (5.83%) reports (16, 23). Not a single female participant in our study has CCVD. It was found that there are statistically significant differences in the prevalence of CCVD based on gender, with a p value of 0.032 ($p < 0.05$). This finding is consistent with existing literature (15, 17) and is explained by the X-linked recessive inheritance pattern of CCVD (1).

While some studies have identified female students with CCVD, no such cases were observed in our cohort (14, 19).

In this study, the most frequent type of color vision defect was deutan, with a deutan / protan ratio of 7 (7/1). The high frequency of deutan (green color) defects was also observed in other studies (5, 20). Total CCVD (achromatopsia) was not detected in this study, which confirms the view that the trait, which is autosomal recessive, is rare (2, 15). Remarkably, all

students identified with CCVD were previously unaware of their condition. This lack of awareness is consistent with research conducted among medical students in Saudi Arabia, Nigeria, and Cameroon (14–16). Following the study, participants diagnosed with CCVD were informed of their condition and its potential implications for their future careers.

Conclusion

In conclusion, this study found that 1.9% of health science students at Wolkite University have color vision deficiency. All affected students were previously unaware of their condition. We recommend mandatory color vision screening for health science students to ensure they can make informed career choices and optimize patient care.

A primary limitation of this study was the absence of an anomaloscope—the gold standard for CVD detection—which restricted our ability to confirm findings and quantify the severity of the deficiency. Furthermore, the study population was limited to university students between the ages of 19 and 28, which may affect the generalizability of the findings to other.

Acknowledgement

We extend our sincere gratitude to Dr. Alemayehu Woldeyes for his invaluable feedback during the writing process. We are also grateful to the Christian Blind Mission (CBM) for providing the funding required for this study. Furthermore, we would like to express our profound thanks to the Director of Wolkite University College of Medicine and Health Sciences, the registrar's office, and all study participants for their cooperation.

Ethical Clearance

The study protocol was approved by the Research and Publication Committee of the Department of Ophthalmology, School of Medicine, College of Health Sciences, Addis Ababa University. The study was conducted in strict accordance with the tenets of the Declaration of Helsinki. Following a brief initial orientation, verbal informed consent was obtained from each participant. To ensure confidentiality, examinations were conducted in private settings, and all personal data were encrypted. Participants identified with color vision impairments received professional counseling regarding the potential implications of the condition on their future careers.

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