ORIGINAL ARTICLE

Impact of Congenital Color Vision Defect on Color-related Tasks Among Secondary School Students in Ibadan, Southwest Nigeria

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ABSTRACT

Aim: To assess the difficulties encountered by students with congenital color vision defects in daily living and school activities. **Methods:** A cross-sectional descriptive study conducted among students of public secondary schools in Ibadan, Nigeria. Structured questionnaires were administered to all consenting students to determine difficulties encountered in aspects of color matching and color recognition. **Results:** A total of 1635 students (male:female 1:1.1) were screened of whom 37 (2.3%) had congenital color vision defect. A statistically significant proportion ($P < 0.0001$) of them reported difficulties with color-related school work and day-to-day activities. **Conclusion:** Congenital color vision deficient students encounter some difficulty with school work and daily living activities, hence a need to identify them early and give appropriate career guidance.

Keywords: Color vision, color vision defect, congenital

INTRODUCTION

There is an increasing use of colors in activities of daily living and individuals with color vision defects encounter difficulties performing certain color-related tasks[1-3] such as in the choice of clothing, differentiating colors in the work environment,[1-4] and may also be at risk of road traffic accidents.[5-7]

Color vision defect can be a handicap in some occupational specialties in medicine such as laboratory science and histopathology; thus, necessitating screening among medical students, medical laboratory workers, and those aspiring to study medicine in some countries.[8-10] A study[11] conducted among medical students showed that students who are color deficient encounter some difficulties in learning. On the other hand, some authors[12,13] reported that color deficient individuals performed well in occupations in which normal color vision was a requirement by developing mechanisms to cope with these activities. However, the evidence from these studies were considered inadequate and inconclusive.[14-16] The Health and Safety Executive[17] in the United Kingdom advises color vision test for employees in occupations where color vision is necessary for safety or quality assurance. Measures like these are, however, not in place in Nigeria, and to the best of the authors' knowledge, there are no studies reporting the effect of color vision defect on color-related tasks in the country. Hence, this study sets out to determine the difficulties encountered by secondary school students with congenital color vision defect in school and daily activities.

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METHODS

This is a descriptive cross-sectional study carried out among secondary school students in Ibadan, Southwest Nigeria.

A multistage sampling technique was used to randomize students from three public co-educational schools out of the 27 registered schools in Ibadan North Local Government into the study. Sample size was calculated using the Leslie Kish formula[18] for single proportions where prevalence was set at 8%[19] at a confidence interval of 95% and a 0.5% precision.

Three secondary schools were selected by simple random sampling. All eligible students in the junior and senior arms of the three randomized schools were recruited into this study. Exclusion criteria included presenting visual acuity of 6/60 or worse in either eye, as severe visual impairment may affect color vision assessment,[20] uniocular visual impairment, or color vision deficiency in one eye which is not typical of congenital color deficiency.

Visual acuity assessment with a 6 m Snellen's chart in a well-illuminated outdoor environment was performed for all the students. Color vision assessment was done with an Ishihara chart (2011 edition) in a well-illuminated room after a detailed ocular examination. Congenital color vision deficiency was diagnosed as inability to read three plates or more of the Ishihara chart in both eyes.[21] Interviewer-administered questionnaires were administered to all the students participating in the study to find out difficulties faced in color-related school tasks and activities of daily living. The questionnaire used in the study by Steward and Cole[22] was modified to reflect the common activities performed by students in this locality. The questionnaire was further validated by a pilot study among secondary school children in a school not randomized into this study. Questions on color identification and matching both at school and away from school were asked. In addition, frequency of difficulty with these activities was assessed.

Ethical approval was obtained from the Institutional Review Board of University of Ibadan/University College Hospital, Ibadan, while permission was also obtained from relevant schools' authorities. Written informed consent was obtained from the parent/guardian of each student and verbal assent from each student.

The data collected were analyzed with the Statistical Package for Social Sciences (SPSS) software version 16 (SPSS for Windows, version 16; SPSS, Inc., Chicago, Illinois, the USA). Means were calculated for quantitative continuous variables while frequencies and proportion were used to summarize qualitative variables. Associations between qualitative variables were determined using Chi-square with level of significance set at 0.05.

RESULTS

A total of 1635 students were interviewed, comprising 769 (47.0%) males with a mean age of 13.9 ± 1.9 years. Thirty-seven (2.3%) students had congenital color vision defect while 1598 (97.7%) had normal color vision.

Fifteen (0.9%) of the 1635 students had difficulty working on the computer while 7 (0.5%) had difficulty identifying different teams during inter-house sports based on colors of jerseys [Table 1]. In activities of daily living, 13 (0.8%) students had difficulty selecting colors of clothes while 5 (0.3%) had difficulty recognizing traffic signals [Table 2].

On cross tabulation of congenital color deficient respondents with normal respondents, a statistically significant proportion of color deficient students had difficulties with color-related school work ($P < 0.001$) [Table 3] and activities of daily living ($P < 0.001$) [Table 4].

DISCUSSION

Various degrees of difficulties with color-related school work were found among both color deficient and noncolor deficient students in our study. However, a statistically significant proportion of students with color vision defects reported more difficulties as compared to those with normal color

Table 1: Difficulties with color-related school tasks reported by students

Variables	Never (%)	Occasionally (%)	Frequently (%)	All the time (%)	No response (%)	Total (%)
Colors and picture chart in mathematics text	1625 (99.4)	4 (0.2)	4 (0.2)	1 (0.1)	1 (0.1)	1635 (100)
Working on the computer	1616 (98.9)	8 (0.5)	5 (0.3)	2 (0.1)	4 (0.2)	1635 (100)
Colors in fine arts	1623 (99.2)	6 (0.4)	4 (0.2)	1 (0.1)	1 (0.1)	1635 (100)
Colors in crafts and hobbies	1623 (99.2)	6 (0.4)	3 (0.2)	1 (0.1)	2 (0.1)	1635 (100)
Identifying houses or teams during inter-house sports based on color of jersey	1626 (99.4)	3 (0.2)	3 (0.2)	1 (0.1)	2 (0.1)	1635 (100)

Table 2: Difficulties with activities of daily living reported by students

Variables	Never (%)	Occasionally (%)	Frequently (%)	All the time (%)	No response (%)	Total (%)
Selecting colors of clothes	1621 (99.1)	10 (0.6)	3 (0.2)	-	1 (0.1)	1635 (100)
Identifying flowers based on colors	1627 (99.5)	2 (0.1)	3 (0.2)	2 (0.1)	1 (0.1)	1635 (100)
Judging ripeness of fruits and vegetables based on colors	1624 (99.3)	2 (0.1)	5 (0.3)	3 (0.2)	1 (0.1)	1635 (100)
Watching sports because of color of team jersey	1628 (99.6)	2 (0.1)	2 (0.1)	1 (0.1)	2 (0.1)	1635 (100)
Recognizing and describing cars based on colors	1626 (99.4)	6 (0.4)	1 (0.1)	1 (0.1)	1 (0.1)	1635 (100)
Recognizing traffic signal lights	1624 (99.3)	2 (0.1)	2 (0.1)	1 (0.1)	6 (0.4)	1635 (100)

Table 3: Effect of color vision on performance with school activities

Performance in color-related school activities	Color deficient (%)			Fisher's exact test	*P*
	Yes	No	Total		
Identifying colors and charts in mathematics					
Some difficulty	6 (66.6)	3 (33.3)	9 (100)	169.714	<0.0001
No difficulty	31 (1.9)	1595 (98.1)	1626 (100)		
Working on the computer					
Some difficulty	9 (60.0)	6 (40.0)	15 (100)	228.170	<0.0001
No difficulty	28 (1.7)	1592 (98.3)	1620 (100)		
Colors in fine arts					
Some difficulty	8 (72.2)	3 (27.3)	11 (100)	248.610	<0.0001
No difficulty	29 (1.8)	1595 (98.2)	1624 (100)		
Identifying colors in crafts and hobbies					
Some difficulty	6 (60)	4 (40)	10 (100)	151.646	<0.0001
No difficulty	31 (1.9)	1594 (98.1)	1625 (100)		
Identifying different houses or teams during inter-house sports based on color of jersey					
Some difficulty	6 (85.7)	1 (14.3)	7 (100)	221.353	<0.0001
No difficulty	31 (1.9)	1597 (98.1)	1628 (100)		

Table 4: Effect of color vision on activities of daily living

Activities of daily living	Color deficient (%)			Fisher's exact test	*P*
	Yes	No	Total		
Selecting colors of clothes					
Some difficulty	7 (53.8)	6 (46.2)	13 (100)	157.646	<0.0001
No difficulty	30 (1.8)	1592 (98.2)	1622 (100)		
Identifying flowers based on colors					
Some difficulty	6 (85.7)	1 (14.3)	7 (100)	221.353	<0.0001
No difficulty	31 (1.9)	1597 (98.1)	1628 (100)		
Judging ripeness of fruits and vegetables					
Some difficulty	8 (80.0)	2 (20.0)	10 (100)	274.901	<0.0001
No difficulty	29 (1.8)	1597 (98.0)	1628 (100)		
Watching sports because of colors					
Some difficulty	4 (80.0)	1 (20.0)	5 (100)	137.029	<0.0001
No difficulty	33 (2.0)	1597 (98.0)	1629 (100)		
Describing and recognizing cars based on colors					
Some difficulty	6 (75.0)	2 (25.0)	8 (100)	192.304	<0.0001
No difficulty	31 (1.9)	1596 (98.1)	1627 (100)		
Recognizing traffic signal light					
Some difficulty	4 (80.0)	1 (20.0)	5 (100)	137.029	<0.0001
No difficulty	33 (2.0)	1597 (98.0)	1630 (100)		

vision ($P < 0.0001$) suggesting that students with color vision defects have more difficulties performing color-related tasks. Many studies[2-4,8,9] have shown that color vision deficiency can be a handicap in color-related tasks, and these may affect the time taken to complete such tasks. Lampe *et al*.[23] in an earlier study among school children, however, reported that color vision deficiency was not found to affect academic performance or intelligent quotient although different parameters were assessed in their study. They used the "Stanford Achievement Test" assessing word meaning, paragraph meaning, word

study skill, spelling, social studies, and arithmetic correlation but not color-related tasks.

A statistically significant proportion ($P < 0.0001$) of color deficient students had difficulty with crafts and hobbies; good color identification is required for the performance of these activities. A study[24] conducted among medical practitioners also showed that color deficient individual had difficulty with clinical signs and laboratory work requiring color identification.

In the area of sports, some students reported having difficulty with recognizing colors of jerseys during inter-house sporting competitions. Of these, a statistically significant proportion ($P < 0.0001$) was color deficient. This is similar to findings by Tiagarelli *et al*.[4] in a comparative study among subjects with normal color vision and defective color vision. Other studies[25,26] among professional cricketers have shown similar difficulties. In activities of daily living, a significant number of students with color vision defects reported difficulties with these activities compared to students with normal color vision ($P < 0.0001$), similar to findings in other studies.[2,22] Tiagarelli *et al*.[4] studied 151 individuals with color deficiency and 302 with normal color vision and found that the color deficient subjects had significant difficulty with selecting colors of clothes, identifying colors in sports, workplace, hobbies, and road signals. Steward and Cole[22] studied individuals with color vision defect and the difficulties encountered with color task. They found a large proportion of the respondents reporting difficulties with color-related activities in daily living and occupation.

A prevalence of congenital color vision deficiency of 2.3% was found in this study similar to other studies[27,28] in our environment. Racial variation in the prevalence of congenital color vision is well-documented with lower prevalence reported in Africans.[29,30] Findings from this study suggest that though there are few people living with this deficiency in our environment, the impact on the life of those affected is significant and further research on this in our environment is suggested.

The parameters used in assessing the difficulties experienced by the students in various color-related tasks may not be applicable to some; however, effort was made to assess the general color-related activities commonly carried out by all students in the study locality.

CONCLUSION

Students with color vision defects have some difficulties with color-related task at school and daily living. Thus, incorporation of color vision screening in school eye health may ensure early detection of students with color vision defect in view to offering them appropriate vocation/career guidance.

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Conflicts of interest

There are no conflicts of interest.

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