ORIGINAL ARTICLE

PREVALENCE OF CONGENITAL COLOUR VISION DEFICIENCY AMONG SECONDARY SCHOOL MALE STUDENTS IN ALMADINA ALMUNAWARA (SAUDI ARABIA)

Al-Ghamdi AK[1], Al-Harbi Z[2] and Al-Ghamdi KS[1]

[1]Family Medicine postgraduate centre, Department of family medicine, Ministry of health, AlMadinah AlMunawara, Saudi Arabia
[2]Department of family medicine, Taibah university, AlMadinah AlMunawara, Saudi Arabia

Corresponding author:
Al-Ghamdi Abdullah Khalid
e-mail: aks-777@hotmail.com

ABSTRACT

The aim of this cross-sectional study is to determine the prevalence of congenital colour vision defects among male secondary school students in Al-Madinah Al-Munawara city, Saudi Arabia. A total of 1154 male secondary school students were selected randomly through a multi-stage sampling method. Ishihara 24-plates was used to screen for colour blindness. The overall prevalence of congenital colour vision defects was 3.3% with 1% protanopes and 2.3% deuteranopes. The prevalence of congenital colour vision defect among Saudis was 2.48% and (5.48%) among non-Saudis. In conclusion, the prevalence of congenital colour vision defect among male secondary school students of Al-Madinah Al-Munawara city is comparable to previously reported in central Saudi Arabia, but lower than for Caucasian.
***Key words**: congenital, colour vision deficiency, Ishihara colour testing, prevalence, Saudi Arabia, protanopes, deuteranopes.*

INTRODUCTION

Colour blindness is a condition where the subject cannot discriminate different colour especially red and green. It is an X-linked recessive condition[1]. At least three cone photopigments are required for human colour vision, known as trichromacy. These are blue , green, and red cone pigments which are called short, middle, and long-wavelength sensitive respectively[2]. Absence of the middle cones is termed deutan, while absence of the long cones is termed protan[2].

Colour vision defect is a result of the absence, malfunction, or alteration of one or more of the photopigments. The term deuteranopia refer to the loss of the medium wavelength i.e. the green colour gene. Ptrotanopia on the other hand refer to the loss of the long wavelength i.e. the red colour gene, and tritanopia refer to the loss of the short wavelength i.e the blue colour gene[3]. Many children grow up without recognising that they are colour blind. Therefore, screening for colour blindness early in their life can help direct them to the right future career.

The prevalence of congenital colour vision deficiency varies from one society to another. One study from Iran revealed a prevalence of 8.3% among male secondary school student[4].In the united states it is reported to affect 8% to 10% of men[(2)]. Another study reported a prevalence of 3.8% among male students in Nigeria[5].On the other hand it was reported as 2.93% and 5.85% in two previous studies in Saudi Arabia[6,7]. To the best knowledge of the author the prevalence of colour blindness among school children in Al-Madinah Al-Munawara has not been determined so far. The objective of this study is to find out the prevalence of congenital colour defect among secondary school boy students in Al-Madinah Al-Munawara.

METHODOLOGY

Study setting and population

This study was conducted in Al-Madinah Al-Munawara (a holy-city), which is situated to the north-west region of Saudi Arabia. A multi-stage sampling technique was used. Al-Madinah Al-Munawara city was divided into four geographical directions. The total number of boys' secondary schools in Al-Madinah Al-Munawara city is 62 schools with a total of 10521 students. Simple random sampling was used to select two secondary schools from each geographical direction (north, south, east and west) giving a total of 8 schools. Each school was divided into three educational levels (1^{st}.,2^{nd}., and 3^{rd}. secondary year level) and one class from each educational level was selected using simple random sampling technique. Finally all students in the selected class were included. A total of 1154 students included in this study. To rule out acquired colour vision defect, students with previous eye surgery, ocular pathology, trauma to the eye, or those on chronic use of medication were excluded.

Instruments
The Ishihara (24-plate edition) was used in this study to find out congenital colour vision defect. The Ishihara colour test[8] is an internationally accepted method for screening red-green colour vision deficiency[9]. It is reported as a very sensitive test for screening for colour blindness[10]. The test was carried out inside the class-room with sufficient daylight, i.e. during day time working hours. The researcher distributed the forms that contain demographic data questions to the students in the selected class. The researcher then explained and clarified the questions to the students and asked them to fill in their demographic data. The bottom of this form contains a table for the students to fill in their answer for the Ishihara's plate numbers. The students are tested for visual acuity using Snellen Visual Acuity chart first. If the student pass this test (i.e. not below 20/30) he will then be asked to perform the colour vision test.

Ishihara colour plates was held 75 cm from the student and tilted so that the plane of the page is at right angles to student's line of vision. All the testing is conducted with both eyes open. Each student is asked to read and write down the numbers of the plates they see in the form, given 3 seconds per plate. The test was performed for all students. Any student who makes more than three errors[9] between plates 1 and 14 during the test session was judged to have failed the screening. Every student considered to have failed the test will be tested a second time. All students are then shown the Ishihara diagnostic plates (16 and 17) to determine if the CVD was protan or deutan type. The researcher and one physician agreed on the same method of screening and performed the test for all students.

Ethical consideration
The study started after obtaining the approval of the research ethical committee on the 2nd. April 2017, in addition to a written consent from every student.

Statistical analysis
All the data obtained were fed into a personal computer and analysed statistically using SPSS program. Chi-square test was used when appropriate.

RESULTS

A total of 1154 male secondary school students were screened for congenital colour defect from eight schools randomly selected in Al-Madinah Al-Munawara city. The distribution of students to the different educational levels are shown in table 1. The students age ranges from15 to 21 years old. A total of 844 (73.1%) students are Saudi and 310 (26.9%) are none Saudi (table 1). Thirty-eight (3.3%) of the 1154 students were found to have colour vision defect (table 2). Among the 38 colour vision defect students, 12 (1%) were protanopia type and 26 (2.3%) were deuteranopia type (see table 3).

Colour vision defect among Saudi students is seen in 21 (2.48%) out of 844 students, and in 17 (5.48%) out of 310 among none Saudi (see table 4). The difference is statistically significant P-value 0.015. Of the 21 Saudi, there were 5 students (0.59%) protanopia type and 16 students (2%) were deuteranopes type. Among none-Saudi 7 students (2.25%) were protanopia and 10 students (3.23%) deuteranope (see table 5). This difference is also statistically significant P-value 0.018.

DISCUSSION

In this study from Al-Madinah Al-Munawara city (north-west) of Saudi Arabia, the prevalence of congenital red-green colour vision defect (CVD) among male secondary school students, is found to be 3.3%. This finding is close to the prevalence quoted 2.93% by Osuobeni among Saudi boys (aged between 11-18 years) from central Saudi Arabia[6]. In spite of the fact that Oriowo and colleague[7] used the 5 error criteria, they reported a slightly higher prevalence 5.85% from central Saudi Arabia among school students. In a nearby, Arab countries a prevalence of 8.72% and 8.47% colour blindness among males was reported in Jordan and Iraq respectively[11].

Different prevalence of congenital CVD was reported in literature in different population around the world[13]. In India, it was reported in one study that the prevalence of colour blindness was 3.2% among children aged 10-17 years[14], and 8.73% in another study[15] among males. A study from Pakistan reported a prevalence of 5.75% CVD among males[16]. In Africa one study from Ethiopia reported a prevalence of 4.2% of colour blindness among children[17], and 3.8% among Nigerian male secondary school students[18].

Table 1. Characteristics of the students enrolled in the study of congenital colour vision defect.

Name of sector and school			
Sector	**School name**	**n**	**%**
Northern	King Abdulaziz	129	11.2
Northern	King Faisal	258	22.4
Western	Khalid bin Alwaleed	113	9.8
Western	Ibn Alqaym	122	10.6
Eastern	King Fahad	172	14.9
Eastern	Abi Saeed Alkhudri	118	10.2
Sothern	Alaqiq	196	17
Sothern	Taibah	46	4
Total		1154	100
Study level of the students			
Level	n	%	
Level 1	422	36.2	
Level 2	302	26.2	
Level 3	430	37.3	
Total	1154	100	
Distribution of ages in years			
Age in years			
15	16	1.4	
16	334	28.9	
17	356	30.8	
18	364	31.5	
19	66	5.7	
20	17	1.5	
21	1	0.1	
Total	1154	100	
Nationality of the students			
Saudi	844	73.1	
Non-Saudi	310	26.9	
Total	1154	100	

Table 2. Prevalence of colour vision defect among male secondary school students in Al-Madinah city

Status of colour blindness	**n**	**%**
Colour blind	38	3.3
Not colour blind	1116	96.7
Total	1154	100

Table 3. Distribution of the different types of colour vision defect among Al-Madinah male secondary school students

Type of colour blindness	**n**	**%**
Protanopia	12	1.0
Deuteranopia	26	2.3
Not colour defect	1116	96.7
Total	1154	100

Using the classification Ishihara plates 16-17, Protanopia is found among 12 students (1.0%) and Deuteranopia among 26 (2.3%) of the total population in this study. These prevalence were close to the ones reported by Osuobeni[6] among Saudis 0.49% and 1.95% for protanopia and deuteranopia respectively. Among Iraqi the prevalence of protanopia 0.55% and 1.5% for deuteranopes[12], and among Jordanians 1.3% protanopia and 1.8% deuteranopia[11].

Table 4. Distribution of colour blindness among Saudi and non-Saudi male secondary school students in Al-Madinah city

Nationality	Colour Vision defect				
	Colour vision defect		Not colour vision defect		
	N	%	n	%	total
Saudi	21	2.48	823	97.52	844
Non-Saudi	17	5.48	293	94.52	310

The ratio of deuteranopia to protanopia in this study is 2.3:1 as compare to 4.3:1.55 reported by Oriowo[7] and 2.4:0.8 reported by Rajkumar study[14]. The classification Ishihara plates 16-17 can be 93% accurate in diagnosing deuteranopes and 82% of protanopes this is a finding by Birch[9]. The prevalence of congenital CVD among Saudis 2.48% in this study is found to be even lower than none-Saudi 5.48%. This is very similar to the prevalence reported by Osuobeni among Saudi boys[6]. The difference between Saudi and none-Saudi could be explained partially by the different ethnicity seen among non-Saudi. Similarly in a study from Singapore [19] different prevalence was noted among Chinse 5.4% , Malay 4.9% and Indian 4.9%. John and his group concluded that (the prevalence of CVD in preschool boys varies by ethnicity, with the highest prevalence in non-Hispanic white and lowest in black children)[20]. A similar prevalence was also reported from north India 2.3% among high school students [21]. The ratio of deuteranopia to protanopia among Saudi in this study is 2.02:0.59 as compare to ratio among non-Saudi 3.23:2.25. This is close to that reported by Osuobeni 1.95:0.49 among Saudis[6].

Table 5. Distribution of the types of colour vision defect among Saudi and non-Saudi male secondary school students in Al-Madina city.

Colour blindness type	Nationality			
	Saudi		None-Saudi	
	n	%	n	%
Protanopia	5	0.59	7	2.25
Deuteranopia	16	2.02	10	3.23
Not colour blind	823	97.39	293	94.52
Total	844	100	310	100
Chi-square =8.04			P-value=0.018	

CONCLUSION AND RECOMMENDATIONS

The prevalence of congenital colour vision defect among male secondary school students of Al-Madinah Al-Munawara city is comparable to previously reported in central Saudi Arabia, but lower than for Caucasian.
From this study, it is recommended to do this simple and cheap test on all school students at least once in their school time.

Limitation

Though this study was done in AlMadina city with a representative sample, a future study should include sample from all over the kingdom of Saudi Arabia to reflect the true figure in the country.

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