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Prevalence of color vision deficiency among primary school pupils in Duhok city, Kurdistan Region, Iraq

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Abstract

Background and objectives: Color vision deficiency or color blindness is a difficulty in recognizing certain colors. The color vision deficient persons remain unmindful about their condition and only become aware accidentally when tested for color vision. Color vision deficiency may affect job performance in certain careers like drivers, pilots, electrical and electronic engineers, policemen, artists, and medical practitioners. The study aims to detect the color vision deficiency prevalence among the primary school pupils in Duhok city.

Methods: A cross sectional study was conducted among randomely selected two primary school children in Duhok city, Iraq from 1st February 2019 to 1st May 2019. Socio-demographic data was collected by interview using a questionnaire. All participants underwent color vision evaluation using Ishihara's pseudo isochromatic test 24 plate editions. Data analysis was done using SPSS version 24.

Results: Out of 978 pupils, 491 were males (50.21%) and 487 were females (49.79%), color vision deficiency was detected in 55 pupils giving a prevalence of (5.63%); among them, 38 pupils have had deutan defects (3.89%) and 17 had protan defects (1.74%). Color vision deficient pupils were 47 males (9.6%) and 8 females (1.64%).

Conclusions: This study found that 5.63% of pupils were color deficient, with male gender predominance. All of the color deficient pupils were unmindful of their condition. Green color deficient pupils (deutans) were more than red color deficient (protans), with zero cases of total color blindness.

Keywords: Prevalence; Color vision deficiency; Ishihara pseudo isochromatic.

Introduction

Color vision deficiency (CVD) arises when there is a fault in the development of one or more types of the retinal cone cells (photoreceptors) that control the color discrimination in light and conducting them into the optic nerve[1].The most common color vision defects are red-green type (protan-deutan). In red-green CVD males are often affected much more than females. Among people with Northern European descent, it occurs in almost 1 in 12 males and 1 in 200 females. Color vision defects of blue-yellow type affect males and females equally. This complaint occurs in less than 1 in 10,000 people worldwide[2].Color vision defects of red-green are inherited as an X-linked recessive pattern. The mistake genes responsible for CVD are located on the chromosome X, which is one of the two sex chromosomes. In males (who have only one X chromosome), one genetic change in each cell is enough to cause the condition, so disorders much more frequently than females[2].In the human retina there are three kinds of cones, which are photoreceptors responsible for the color vision, each containing a different photopigment and that are maximally sensitive to one of the three fundamental

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colors: green, red, and blue[3] Many CVD persons cannot discriminate against certain colors (anopia), whereas others have only a color weakness (anomaly). Persons with normal color vision and those with protanomaly, deuteranomaly, and tritanomaly are called (trichromats); they possess all three kinds of cones, but one of them may be impaired. Individuals who are dichromats, have only two types of cone cells; and might exhibit deuteranopia, protanopia, or tritanopia. Monochromats have only one cone system[3- 4]. The genes of red and green pigments are distributed in a tandem matrix on the X-chromosome, one red-pigment gene followed by one or more green-pigment genes. Alteration or deletion of the green-pigment genes may occur due to the great symmetricalness between these genes. The high isomorphism between these genes may result in. Such events constitute the most common cause of red-green color vision defects[5]. The main purpose of existing programs of CVD screening through schools is to counsel the affected children concerning certain vocations and occupations. Other methods of telling color vision deficient young people about the possible occupational difficulties and referring them to specialists for assessment are apparent to be more appropriate[5].Congenital CVD is an unseen disability; its effects become visible only when the affected children enter the kindergartens and schools, where they frequently face learning difficulties and often considered as unintelligent pupils, with subsequent psychological disturbance, additionally, they may get dissatisfaction from their teachers and parents[6]. The study aims to detect the color vision deficiency prevalence among a sample of pupils in the primary school in Duhok city.

Subjects and methods

In this cross-sectional study, two elementary schools (Charsteen and sienna) in Duhok city were enrolled randomly by lottery, the target population was all pupils of grades 1, 2, and 3 (males and females), each school has two shifts, morning and evening, and each grade has three classes in each shift, so six classes for each grade in every school were enrolled. The first school (Charsteen) is located in the Northwest, while the second one (Sienna) is located in the South west of the city. The study was approved by the Research Ethics Committee of the Kurdistan Board for Medical Specialties and permission consent from the directorate of education in Duhok city. Color vision screening carried out via Ishihara pseudo isochromatic 24 plate's book. It contains different forms and designs of plates with introductory, transformation, vanishing, hidden digits, and classification plates. The data of the current study were collected by the observer, who has practice and expert in ophthalmology branch (being practicing in two hospitals and two primary health care centers as an ophthalmologist). Screening has been done in an allocated room with sufficient daylight and Ishihara plates were held 75 cm from the pupil at a right angle to his gaze. The pupils were asked to look at each plate binocularly, then to reply in just (4) seconds. Any pupil, who made three misinterpretations or more in the first 10 plates, had to undergo a second trial of testing including all the 24 plates, if misreading of three or more plates remained, then labeled as a color vision deficient. Furthermore, to classify them as protan or deuteran ones, the plates (16 and 17) were used to achieve this purpose. The sample size was calculated assuming that prevalence is 50% of population, because this study is conducted in the center of Duhok city (Duhok government districts and outskirts were not included, and it was not at the Kurdistan provincial level to take Shekhan or Erbil prevalence rates), so the prevalence is unknown as this study is the

first one to be undertaken in the city center of Duhok, for this reason the prevalence assumed to be 50% of population according to the regulations of the epidemiologists to get the maximum sample size, using the following equation: $N= (PQZ^2)/E^2$ was used in the estimation of sample size, N = the sample size, P= the estimated prevalence of 50%, Q= equals 100% minus estimated prevalence, Z= the 95% confidence level which is 1.96, E= the accepted standard error which is 0.05. N=0.5*0.5*1.96*1.96/0.05*0.05=384 [7]. This sample size was multiplied by 2 for the comparison purposes between males and females, so the sample size was 768. In this study, because the inclusion subjects were all the pupils in grades 1, 2, and 3, so the sample size became 978 representing all the included pupils, which is far beyond the supposed one, hence increasing the power of the study. Analysis of data was achieved by the statistical package for social sciences (SPSS, version 24), for the comparisons among the groups in the study, Chi square test was used and the significance level was ≤ 0.05.

Results

Table (1) shows out of 978 screened pupils 55 pupils were considered to have color vision deficiency giving a prevalence of (5.63%). The results in the Table (1) demonstrate the total number of males and females in the study and revealed that among 491 males 47 (9.6%) were color deficient and among 487 females, 8(1.64%) were color deficient. Males have a significantly higher prevalence than females (p-value < 0.0001). Table (2) and Figure (1) show the types and severity of the color deficiency with gender distribution. Among the 47 male pupils shown to have color deficiency, 14 (2.85%) of them were deuteranomalous, 6 (1.22%) protanomalous, 19 (3.87%) deuteranopes and 8 (1.63%) protanopes. In other words the number of severe cases of color vision deficiency (deuteranopes and protanopes) was 27 (5.5%) of males. Among the 8 color deficient female pupils, 6 of them were deuteranomalous (1.23%), 2 (0.41%) protanomalous, with no deutranopes and protanopes cases. No severe cases were found among the females

Table (1): Distribution of the cases of color vision deficiency according to the gender**:**

Gender	No Color deficient		Color deficient		Total		p-value
	No.	%	No.		No.	%	
Male	444	90.4%	47		491	100.0	<0.0001
Female	479	98.4%	8		487	100.0	<0.0001
Total	923		55		978	100.0	

In this study, the prevalence of color vision deficiency according to the gender was found to be statistically significant, p- value (X^2 >28.966) < 0.0001, with male gender predominance.

Table (2): Distribution of the cases of CVD according to the gender and types:

Gender	Color deficients	Deuteranomalous	Protanomalous	Deuteranopes	Protanopes
Male	47 (9.57%)	14 (2.85%)	6 (1.22%)	19 (3.87%)	8 (1.63%)
Female	8 (1.64%)	6 (1.23%)	2 (0.41%)	0 (0%)	0 (0%)
Total	55 (5.63%)	20 (2.05%)	8 (0.82%)	19 (1.94%)	8 (0.82%)

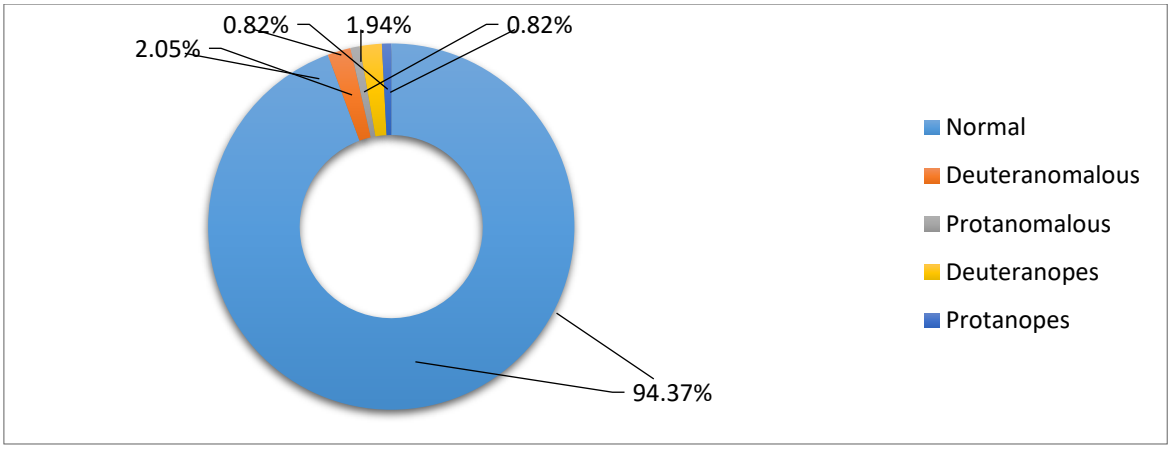

Figure (1): Distribution of the cases of color vision deficiency according to the types

It is worth mentioning that the results in both schools were very close and obvious differences were unnoticeable.

Discussion

Color blindness is a very common inherited disorder affecting more than 300 million individuals worldwide, 1 in 12 males and 1 in 200 females [2-8]. The retinal anomaloscope was not available, which is the "gold standard" of color vision screening mainly in grading the severity and differentiating the red-green types, (although it's practice is more difficult and it is not applicable in young children and the diminished cognition persons) [9,10], accordingly color vision screening was carried out via Ishihara Pseudo Isochromatic 24 plates' book, which is from the time when designed in the last century (1917 by Ishihara was regarded as the most familiar and the most applicable color vision test globally[11], and also could be successfully achieved by children aged 3-6 years[12]. The Ishihara plate test demonstrated a sensitivity of 0.97 and a specificity of 1.00 for the color-deficiency screening[13] and could detect people with trivial red-green color vision deficiency[14]. There is a significant difference in the incidence of preschool children with color vision deficiency concerning the ethnicity and the geographical location, being highest in the non-Hispanic white ethnicity (8% in males and about 0.4% in females) and lowest in the blacks[3- 15]. The overall prevalence of color vision deficiency is 5.63% in this study, furthermore the prevalence among boys is 9.6% and among girls is 1.64%, which is above the hispanic range. Other studies that had been conducted in Kurdistan region and Iraq revealed that the prevalence of color vision deficiency in Shekhan high schools students (sample size n = 640 students, 283 males and 357 females) was 6.8% of male and 0.8% of female pupils[16], which is lower than the prevalence of this study for both males and females, which may be due to the multi-ethnic society of Shekhan district whish is component of Muslims, Yazidis, and Christians, as among 640 students enrolled in Shekhan study, 97 were Yazidis and 3 were Christians, estimating 16% of the sample size, while in the current study, 3 students were Yazidis, and 3 were Christians, estimating 0.6% of the total sample size. Another study conducted among different ethnic groups of students in Erbil city[17] (n =1856, 1275 males and 581 females), the prevalence of color vision deficiency was 8.47% of males and 1.37% of females students, which is lower than the results of this study taking in consideration the larger sample size of the mentioned study, which is as twice as the sample size in our study. Other studies conducted in Iraq, were among Baghdad males[18] (n = 1005

males), the prevalence of color vision deficiency was 4.75% , and among Iraqi Arabs in Basrah and surrounding areas the prevalence was 8.19% in males and 3.2% in females[19] , with a higher female prevalence than our study. Similarly, studies in the nearby countries found that the prevalence of color vision deficiency was: 8.72% of males and 0.33% of females (n=1418, 218 males and 1200 females) in Jordan[20], 7.33% among the Turkish males (n=941 males)[21], 5.85% of males and 0.75% of females (n=1638, 838 males and 800 females) among the Saudi Arabia children[22], and 1.6% of males, 0.2% of the females (n=1000) in Zahedan, Iran[23] which is obviously lower than predicted. The prevalence of color vision deficiency among the males and females in the present study is higher than prevalence rates in the above countries and higher than the global range, which is near 8% in boys and 0.4% in girls of Caucasians ethnic group[3- 15- 24] and between 4% and 6.5% in males and 0.7% and 1.7% in females of Japanese and Chinese ethnicities[24]. The results in the current study could be attributed to the high range of concealed kinship marriages in Duhok city (consanguineous marriages) since the clannish traditions are very strong. The vast majority of the residents of Duhok city are Muslim Kurds, so the ethnic factor also may have a role in these results, so further studies must be conducted enrolling the socioeconomic and sociodemographic statuses and the parentral level of education.

Conclusions

This study has found that more than 5% of pupils were suffering from color vision deficiency. All cases were of the red-green type (Deuteran and Protan) with no total color blindness. Neither; all the color deficient pupils, nor their families were aware of their conditions before this study. All the severe cases were only among the male pupils. Further studies are recommended, using the standard instrument of anomaloscope for the screening and the gene study (if possible).It is highly recommended to screen all the pupils, especially the males for color vision deficiency at primary school entrance through the school health program belongs to the general directorate of health /Duhok province.

Conflicts of interest

There were no conflicts of interest.

References

1. Shah A, Hussain R, Fareed M, Afzal M. Prevalence of Red-Green Colour Vision De-fects among Muslim Males and Females of Manipur, India. Iran J Public Health. 2013; 42(1): 16-24.
2. Genetics Home Reference 2020, Color vision deficiency, viewed 2020.<https://ghr.nlm.nih.gov/condition/color-vision-deficiency#sourcesforpage-
3. Barrett K, Brooks H, Boitano S, Barman S. Ganong's Review of medical physiology. 23rd ed. Lange Medical Books/McGraw-Hill publisher; 2010.p.195-7.
4. Neitz M, Neitz J. Molecular genetics of color vision and color-vision defects. Arch Ophthalmol. 2000; 118 (5): 691-700.
5. Cumberland P. Impact of congenital colour vision defects on occupation. Arch Dis Child. 2005; 90(9):906-8.
6. Chakrabarti S. Psychosocial aspects of colour vision deficiency: Implications for a career in

medicine. Nat Med J India. 2018; 31(2):86-96
7. Calculation of Sample Size. ResearchGate, 2020 https://www.researchgate.net/post/Calculation_of_Sample_Size
8. Inherited color vision deficiency. Color blind awareness, Oxfordshire: England, viewed 2019. http://www.colourblindawareness.org/colourblindness/inheritedcolourvisiondeficiency
9. Barbur J, Rodriguez-Carmona M. Colour vision requirements in visually demanding occupations. Br Med Bull. 2017; 122(1):51-77.
10. Fanlo ZA, Gutiérrez VJ, Pueyo RV. Review of the main colour vision clinical assessment tests. Arch Soc Esp Oftalmol. (English Edition). 2019; 94 (1):25-32.
11. Ishihara Test for Color Blindness, Color Blindness, 2019. https://www.colour-blindness.com/colour-blindness-tests/ishihara-colour-test-plates
12. Choi S, Hwang J. Ishihara test in 3- to 6-year-old children. Jpn J Ophthalmol. 2009; 53 (5): 455-7. doi: 10.1007/s10384-009-0716-1. Epub 2009.
13. Marechal M, Delbarre M, Tesson J, Lacambre C, Lefebvre H, Froussart-Maille F. Color Vision Tests in Pilots' Medical Assessments. Aerosp Med Hum Perform 2018; 89(8):737-43.
14. Birch J. Identification of red-green colour deficiency: sensitivity of the Ishihara and American Optical Company (Hard, Rand and Rittler) pseudo-isochromatic plates to identify slight anomalous trichromatism. Ophthal Physiol Opt. 2010; 30 (5):667-71. DOI: 10.1111/j.1475-1313.2010.00770.x
15. Xie J, Tarczy-Hornoch K, Lin J, Cotter S, Torres M, Varma R. Color Vision Deficiency in Preschool Children. Ophthalmology. 2014; 121 (7):1469-74.
16. Abdulrahman M. Prevalence of Color Vision Deficiency among Students in Hajand and Amad High Schools in Shekhan City. Kurd J Appl Res. 2017; 2 (2):84-8.
17. Karim K, Saleem M. Prevalence of Congenital Red-Green Color Vision Defects among Various Ethnic Groups of Students in Erbil City. Jordan J Biol Sci. 2013; 6 (3):235-8.
18. Almusawi BMS. The Prevalence of Color Vision Deficiency among Adult Males from Baghdad Province. Iraq postgrad Med J. 2014; 13 (1):134-9.
19. Al-Amood W, Mohammed S, Al-Sanawi D, Radhi A, Rehman B. Incidence of Colour Blindness in Iraqi Arabs. Hum Hered. 1981; 31(2):122-3. https://doi.org/10.1159/000153191
20. Al-Aqtum M, Al-Qawasmeh M. Prevalence of Colour Blindness in Young Jordanians. Ophthalmologica. 2000; 215(1):39-42.
21. Citirik M, Batman C. Congenital Color Blindness in Young Turkish Men. Ophthal Epidemiol. 2007; 14 (2):99-100.
22. Oriwo OM, Alotaibi AZ. Colour Vision Screening among Saudi Arabian Children. S. Afr J Sci. 2008; 67(2):56-61.
23. Momeni-Moghaddam H, Ng J, Robabi H, Yaghubi F. Color Vision Deficiency in Zahedan, Iran. Optom Vis Sci. 2014; 91(11):1372-6. doi: 10.1097/OPX.0000000000000393
24. Birch J. Worldwide prevalence of red-green color deficiency. J Opt Soc Am. 2012; 29(3):313-20.