**Prevalence And Allele Frequency Of Colour Blindness In Al-Najaf Al Ashraf Province**

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**ABSTRACT**

**Background:** Colour blindness or colour vision deficiency is an inability or reduced ability to described certain colours, there are several types of colour blindness but the more common type red-green colour blindness that inherited x-linked disorder, hence it was more distribution in males (hemizygote) but it was less prevalent in females because she had two x chromosomes, she may be affected or a carrier to disorder. We examined 2470 participant (2158 male and 312 female) by using Ishihara plate (24 plates edited). This study conducted to find out the prevalence of colour blindness in Al-Najaf province. In the present study, Among those was screened for colour deficiency, 107 of them (4.33 %) were diagnosed with colour blindness, the rate was a difference among gender 105 (4.87 %) in male and it was 2 (0.64) % in female. The deuteranomaly was the highest type 38 (35.51 %) then deuteranopia was 31 (28.97 %), the protanomaly was 23 (21.50 %), the protanopia was 10 (9.35 %), At last, the achromacy was lowest 5 (4.67 %) among infected colour blindness. The deutan : protan ratio was 2.03:1. This rate (in our study) was approximately similar to the rate recorded in Al-Qadisiyah University (5.2 % in male and 0.4 % in female) and less the rate in the centre and north Iraq (Baghdad, Duhok and Erbil province).

**Keywords:** Colour Vision Deficiency, Colour Blindness, Deutan, Protan, Pseudoisochromatic Plates, Ishihara Test And Al- Najaf Province.

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**INTRODUCTION**

The normal colouration of human vision is mediated by three cone photoreceptor classes: a blue or wave sensitivity (S), a medium wave or a green wave sensitivity(M) and a long-wave or a red wave sensitivity. (Moudgil 2016). Colour Vision Deficiency (CVD) means that certain color combinations and changes in color cannot be distinguished under normal conditions of lighting. There are two types of colour vision defects: first, most cases are congenital and permanent, second, there are acquired color vision defects in rare cases (Cumberl et al, 2005).

Red and green colour defects (protan and deutan)show the highest incidence in the world, red and green colour blindness is genetically determined by recessive X-linked genes within the distal part on q arms on locus (Tagarelli, Piro, and Tagarelli 1999) (Geletu, Muthuswamy, and Raga 2018), While on autosomal chromosome7 the Blue Pigment gene is 7q32 (Ooe et al. 2018). Factors such as optic nervous damage, metabolic disorders like diabetes, diseases of the eye (glaucoma, macular degradation) and chronic diseases may cause acquired CVD (such as sickle cell anemia) (Ross, 1962). Generally, there are two kinds of defects protan and deutan, in case the absence of L (red) cone pigment or M (green) cone pigment will produce protanopia and deuteranopia, respectively. The other case if there is an abnormality in the L or M cone pigment that would produce protanomaly and deuteranomaly (Cole, 2007). The Prevelance of color blindness varies from region to region.
and differs in different geographic areas. For example, the rate was 6.75% among males in Baghdad province (Al-musawi, 2014), it was 6.36% among males and 0.84% among females in Shekhan city Duhok province, Kurdistan Region, Iraq (Abdulrahman, 2017). It is was 5.2% in male and 0.4% in female at Al – Qadisiyah University(Iraq)(Hamied and Jabar 2018). It was 8.47% among males and 1.37% among females in Erbil city, Kurdistan Region, Iraq (Simunovic, 2010)(Karim and Saleem, 2013). It was 5.75% in males and 1% in females in Quetta city, Pakistan (Hamida et al. 2016). It was 5.85% in males and 0.75% in females in Saudi Arabia (Oriowo and Alotaibi 2008). It was 8.73% in males and 1.69% in females in six populations in Manipur, India (Shah et al. 2013), the prevalence was 3.75 % in males and 0.68 % in females to CCVD at Hawassa University, Ethiopia (Mitiku, Tolera, and Tolesa, 2020). People with poor colour vision are at a particular disadvantage with working in professions such as pilots and drivers in technical fields such as medical, engineering and defense professionals (Moudgil, 2016). In addition to this in some fields of studies such as laboratory, forensic science, chemical engineering, electrical engineering, agriculture, soil engineering and architecture.

**MATERIAL AND METHODS**

1: Study area

This study was conducted by committees of medical examination in Al- Najaf province especially the driving medical examination committee.

2: Subjects for research and design

A descriptive cross-sectional scan was carried out to determine the colour vision deficiency. Individuals who wanted a medical exam were inclusion criteria, their age between 18-65 years, with normal eye conditions, who gave their consent. In present study, 2470 individuals involved (2158 male, 312 female).

3: Pseudoisochromatic plates (Ishihara test)

One of the best ways to check for colour vision deficiency is pseudoisochromatic plates. There are three versions of these plates; 38 plates, 24 plates, and 14 plates. In present study, a copy of 24 plates was used, and the copy contains five sets of plates:

1. Panel 1 is an introductory plate that everyone can read properly.
2. Panels 2-7 are conversion or confusion panels where people with normal vision and persons with defects of colour vision see a different number.
3. Panels 8-13 are vanishing plates where regular trichromatic people can read the correct number while colour vision defective people cannot see any number.
4. Panels 14 and 15 are hidden number plates where only visible colour defect can read numbers.
5. Rating plates 16 and 17 are designed to distinguish between red and green colour blindness (Miyahara, 2008). It was put plates on the colour vision test after 75 cm from the subject at the right angles to the line of sight.

4: Genetic data analysis

The CVD phenotypes were recorded for all participants and then allele frequencies were calculated depending on Hardy-Weinberg’s law \( (p^2 + 2pq + q^2 = 1) \) using the gene count method. (Shah et al. 2013)(Mitiku, Tolera, and Tolesa, 2020). The level of heterozygosity was calculated by using:

\[
\text{Heterozygosity} = 1 - \sum H_0
\]

Where \( H_0 \) is the homozygosity of the allele, \( H_0 = \sum P_i^2 \)

5: Allele frequency analysis

Supposing that the population is not of the same ancestor, the frequencies of the normal allele (p), deutan allele (q), protan allele (s). The allele frequency is expected in the female account using allele frequencies for males infected but has been reported to the actual allele frequencies for females based on the infected female.
RESULT

1: Phenotypic frequency of colour vision deficiency

We took in this study about 2470 study subjects which 2158 (87.37%) were male and 312 (12.63%) were female. The age of the participants ranged from 18 - 68 years. 107 had CVD that including 105 males and 2 females. The prevalence of CVD in male was 4.87% and in female was 0.64% (see table 1).

Table (1): Colour vision deficiency (CVD) prevalence by gender

<table>
<thead>
<tr>
<th>Combined</th>
<th>Color blind (%</th>
<th>Total (n)</th>
<th>Male</th>
<th>Colour blind (%</th>
<th>Total (n)</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (%)</td>
<td>2363(95.67)</td>
<td>107(4.33)</td>
<td>2470</td>
<td>2053(95.13)</td>
<td>105(4.87)</td>
<td>2158- 310(99.36)</td>
</tr>
</tbody>
</table>

In the current study, the number of males affected with deutan was highest among the population in Al- Najaf province 67 (3.10%) and protan was 33 (1.53%), where deuteranomaly was 37 (1.71%) deuteranopia was 30 (1.39%) protanomaly 23 (1.07%), protanopia was 10 (0.46%) and Achromacy 5 (0.23%). On the contrary, in female deuteranomaly was 1 (0.32%), deuteranopia was 1 (0.32%) but we did not found the other phenotypes (see table 2).

Table (2): Male and female phenotypic frequency of achromacy and various types of CVD

<table>
<thead>
<tr>
<th>Sex</th>
<th>N</th>
<th>Achromacy</th>
<th>Deutan</th>
<th>Deuteranopia</th>
<th>Deuteranomaly</th>
<th>Protan</th>
<th>Protanopia</th>
<th>Protanomaly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>2158</td>
<td>5 (0.23)</td>
<td>30 (1.39)</td>
<td>37 (1.71)</td>
<td>10 (0.46)</td>
<td>23 (1.07)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>312</td>
<td>0 (0.00)</td>
<td>1 (0.32)</td>
<td>1 (0.32)</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2: Allelic and genotypic frequency of colour vision deficiency

If the males are hemizygous (i.e. only one X chromosome), the allel frequency in males in CVD would be the same for the blindness of colour (0.048), while the frequency of the observed (actual) allele in females was to CVD (0.006). Depending upon the allele frequencies of CVD in males, the predicted allele frequencies of CVD in females were (0.048^2 = 0.0023). The heterozygotes were (8.6%), see Table (3).

Table (3): The allelic frequencies of normal, hemzygote, double hemzygote and colour blindness (male and female subjects)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>2953</td>
<td>2153</td>
</tr>
<tr>
<td>Deutan</td>
<td>67</td>
<td>23</td>
</tr>
<tr>
<td>Protan</td>
<td>33</td>
<td>3</td>
</tr>
<tr>
<td>Total (n)</td>
<td>2153</td>
<td>2153</td>
</tr>
<tr>
<td>Deutan</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Protan</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Heterozygote</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Double heterozygote</td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Colour blind</td>
<td>0.002</td>
<td>0.002</td>
</tr>
</tbody>
</table>
3: Relative parents

From the 107 affected there were 66 (61.7%) having relative parents whereas 41 (38.3%) did not have relative parents see table (4).

Table (4): Clarify relative parents among affected colour blindness

<table>
<thead>
<tr>
<th>Relative Parents</th>
<th>Yes %</th>
<th>No %</th>
<th>N %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>66(61.7)</td>
<td>41(38.3)</td>
<td>107(100)</td>
</tr>
</tbody>
</table>

4: The relationship of CVD to habitat

From the 107 affected, there are 73 (68.25%) live in the centre of the province and the other 34 (31.75%) live in the peripheral of the province see figure (1).

![habitat](image)

**Figure (1):** Clarify the rate affected by habitat.

**DISCUSSION**

The overall prevalence of CVD was lower compared to the recorded in Baghdad(Iraq) between adults males 6.75 % (Al-musaw 2014), furthermore, It was less than recorded in Duhok province, Iraq that was 6.36 % in males and 0.84% in females (Abdulrahman, 2017), also it was lower from Erbil province, Iraq was 8.47% among males and 1.37% among females (Karim and Saleem, 2013), the proportion was lower from the Quetta city, Pakistan where it was 5.75% in males and 1% in females (Hamida et al. 2016), the ratio of CCVD less than in Saudia Arabia that it was 5.85 % in males and 0.75 % in females (Oriowo and Alotaibi, 2008), the proportion of CCVD was less than Manipur, India which it was 8.73% in males and 1.69% in females (Shah et al. 2013), but the ratio was approximately equal to these in Al-Qadisiyah University, Iraq (Hamied and Jabar, 2018), and the ratio was more than in Hawasaa University Ethiopia (Mitiku, Tolera, and Tolesa, 2020), furthermore, the rate in the present study was higher from the south Africa in Durban among school children which it was 4.2% in males and 0.6% in females (Mashige and Staden, 2019). It is very important to examine all the school children colour blindness and chose their career later on wisely. we conclude from this study, the rate of prevalence colour vision deficiency was 4.33 %, while the rate in males was 4.87% and less in the females was 0.64 %.where deuton was more than protan, The ratio of deutan:protan was 2.03:1. There is a relationship between the distribution of CVD and relative parents, we were observed the increasing rate of this disease between them. Also, we noted that the rate of CVD was higher in the male because he has only one X-chromosome, whereas the female has two X chromosome so it can be a carrier or affected. Prevalence CVD was no relationship by habitat. We are recommended that is a benefit to a conducted early exam of colour blindness to the school children to direct them for their own future jobs.

**CONCLUSION**

This study conducted to find out the prevalence of colour blindness in Al-Najaf province.

In the present study, Among those was screened for colour deficiency, 107 of them(4.33%)were diagnosed with colour blindness, the rate was a difference among gender 105(4.87 %) in male and it was 2(0.64 %) in female.

The deuteranomaly was the highest type 38(35.51%) then deuteranopia was 31(28.97 %), the protanomaly was 23(21.50%), the protanopia was 10(9.35%), At last, the achromacy was lowest 5(4.67 %) among infected colour blindness.
The deutan : protan ratio was 2.03:1. This rate (in our study) was approximately similar to the rate recorded in Al-Qadisiyah University (5.2% in male and 0.4% in female) and less the rate in the centre and north Iraq (Baghdad, Duhok and Erbil province).

Ethical clearance

We take approved from all participants before conducting the examination. This study has passed of the ethical committee in the science college University of Kufa.

Acknowledgements

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