ORIGINAL ARTICLE

Frequency of Colour Blindness amongst the Young Age Group in a Tertiary Care Eye Hospital

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ABSTRACT

Purpose: To determine the frequency of color vision deficiency among young age groups visiting a tertiary care eye hospital for pre-employment health screening.

Study Design: Descriptive, cross sectional study.

Place and Duration: Armed Forces Institute of Ophthalmology, Rawalpindi, from June 2018 to December 2019.

Methods: Data was collected using non-probability consecutive sampling technique. All candidates who appeared for medical fitness for pre-employment screening were included. Candidates belonged to various regions of Pakistan. Informed consent was taken. Complete history and ophthalmic examination including visual acuity, best corrected visual acuity, anterior segment examination and dilated posterior segment examination was performed. Intra ocular pressure was measured by Goldmann Applanation Tonometer. Colour vision was checked before pupillary dilation using Ishihara test plates. Candidates were clearly instructed about test plates. Candidates with ocular abnormality were referred to the specialized units. The data analysis was done by IBM SPSS 20 software.

Results: One thousand and five hundred (1500) candidates were screened. Out of these, 88.3% (1325) were males and 11.6% (175) were females. Mean age of the candidates was 20.35 ± 4.46 years. Approximately five percent (4.8%, n = 73/1500) candidates had color vision deficiency. Out of these, 94.52% (69) candidates were unaware of their condition.

Conclusions: Color blindness in this study was 4.86%. Majority of the color blind persons were males and most of them were unaware of their condition.

Key Words: Colour blindness, Ishihara plates, X-linked, Red green deficiency.

How to Cite this Article: Khan S, Rafique A, Khizer MA. Frequency of Colour Blindness Amongst the Young Age Group in a Tertiary Care Eye Hospital. Pak J Ophthalmol. 2021, **37 (2):** 142-146.

Doi: http://doi.org/10.36351/pjo.v37i2.1180

INTRODUCTION

Colour blindness is a condition in which there is faulty development of one or more sets of retinal cone photoreceptors. In this condition there is complete absence or decreased perception of colour and hue differences under normal illuminating conditions. There is variation in frequency of color blindness in different ethnic populations worldwide. Humans have trichromatic colour vision. Presence of three spectrally-distinct types of cone photoreceptors in retina leads to perception of this trichromatic colour vision. These various types of cones are maximally sensitive to light of different wave lengths. These wave lengths are 420, 530 and 560 nm. As a result, these cones are termed as short, middle and long wave length sensitive cones with respect to their sensitivity domain.[1] This distinct spectral sensitivity of cones leads to immaculate colour vision discrimination in

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Received: December 11, 2020
Accepted: February 16, 2021

humans. Colour vision deficiency is one of the commonest visual disorders and can be grouped as either congenital or acquired. Mutations in X chromosome is the most common heritable pattern. X-linked red green deficiency is the most wide spread form of color vision impairment. It is therefore more common in males. Colour vision deficiencies are due to mutations in the genes encoding the above mentioned three spectral sensitive cone pigments.[2] Hybrid cone opsin gene undergoes a missense mutation. It leads to X-linked cone dystrophy.[3] The blue pigment gene is harboured on chromosome 7. Long arm of the X-chromosome (Xq28) entails red and green pigment genes for trichromatic vision. The carrier mothers of the abnormal gene renders a chance of 50% her of sons with anomalous colour vision. X-chromosomes is transferred to daughters only by colour vision deficient fathers, rendering all daughters to be carriers of trait. However, sons have no difficulty in colour perception.[4]

Colour vision provides basic sensory information to organisms of their surroundings. It is one if the basic mechanisms of survival where we use our colour instincts to find food and water. Although it is a common condition, still, most of the patients with colour vision deficiency are not aware of their condition and it remains an unnoticed problem. However, various problems such as disability in job (25%), career selection (33%), judgment in daily routine (75%) and traffic signal recognition (13%) are consequences of this condition.[5] Colour vision standards are clearly identified and established in fighting arms, aviation and land communicating railway fields and are effectively employed in these fields. The reason for establishment of these clear protocols is due to the fact that these jobs are highly colour sensitive and colour dependent. One little misinterpretation of colour marking may lead to huge loss of lives and material. Due to this, according to UK health and safety executive, normal colour vision is required for purpose of safety and quality. Colour vision deficiency put an imminent risk in professions like army, aviation, navigation, police, pharmacists and firefighting services. In addition to this, colour blind individuals may decrease the quality of productivity in jobs like textile industry, fine arts and photography.

There is scanty data available in Pakistan and population based studies are lacking. We have an increase number of candidates who are referred for ocular assessment including colour vision as vital part of their pre-employment screening. In our study, we aim to assess the prevalence of colour vision impairment among Pakistani population presenting for pre-employment medical examination in a tertiary eye care hospital. This study will provide basis to consider colour vision deficiency as an important ocular pathology which should be ruled out in candidates who appear for colour sensitive jobs.

METHODS

This study was conducted over a period one and a half year from June 2018 till Dec 2019 in Armed Forces Institute of Ophthalmology. Study was initiated after taking approval from hospital ethical review committee. In this cross-sectional study, a total of 1500 candidates were included using non probability consecutive sampling technique. Sample size was calculated using WHO sample size calculator, keeping confidence interval of 95% and 5% error. The study included all candidates appearing for pre-employment ocular examination. Individuals with history of ocular or neurologic surgery, trauma, anti-tuberculosis treatment or central nervous system drugs, prior history of intra ocular inflammation, candidates having systemic diseases like diabetes, hypertension and other organ systems were excluded. Informed consent. Unaided vision and best corrected visual acuity was assessed. Colour vision was assessed with the best correction in trial frame. Ishihara isochromatic colour plates were read by each candidate held at 75cm in front, perpendicular to the line of vision in a well illuminated place. Each plate was presented for five to seven seconds and candidate was requested to read the number or recognize the pattern present on plate. The candidate who read all the plates properly were considered normal while those who could not read the plates accurately or confusingly were considered to be colour vision deficient. Slit lamp examination of anterior and posterior segments along with intra ocular pressure measurement with Goldmann Applanation tonometer was carried out. Individuals who were found to have ocular pathologies were referred to specialized units for further work up and treatment. Data was entered and analyzed in SPSS version 20. Descriptive statistics were used to calculate mean and standard deviation of age. Percentage was calculated for the presence or absence of colour blindness and awareness of this ailment.

RESULTS

One thousand and five hundred (1500) candidates underwent ophthalmic medical fitness examination during June 2018 to December 2019. Out of these, 88.3% (1325) were males and 11.6% (175) were females. Mean age of the candidates was 20.35 ± 4.46 years. Overall 4.8% (73/1500) of the candidates had vision deficiency. There were 94.6% (70) males and 4.1% (3) were females (table 1 and 2). Out of them, 94.52% (69) candidates were unaware of their condition.

Table 1: *Frequency of Colour Blindness by Age group.*

Age Group (Years)	Number of Candidates	Candidates with Colour Vision Deficiency	
		Number	Percentage (%) Out of Screened Candidates
≤ 20	370 (24.6%)	18	4.86
≥ 21	1130 (75.4 %)	55	4.86
Total	1500	73	4.86

Table 2: *Frequency of Colour Blindness by Gender.*

Gender	Number of Candidates	Candidates with Colour Vision Deficiency	
		Number	Percentage (%) Out of Screened Candidates
Male	1325 (88.4%)	70	5.28
Female	175 (11.6%)	3	1.71
Total	1500	73	4.86

DISCUSSION

Color vision was one of the basic strategy of survival of the fittest where our ancestors were able to differentiate between food for living and danger zones. Colour vision deficiency is reduced or total absence of perception of colour. Visual acuity is unaffected hence it is difficult to detect in routine ocular examination and often go unnoticed by individuals. However, pre-employment screening is a helpful modality to identify individuals with such deficiencies. This also marks importance of maintaining safety and quality of jobs which requires intricate colour perception. Moreover, colour deficient individuals in field of telecommunication put a hazard when they are unable to identify wiring of basic colour.

There are various tests used for assessment of colour vision e.g. Ishihara test plates, Fransworth Munsell 100 hue test and City University test. Ishihara test can only differentiate congenital colour vision deficiency, it is user friendly, easier to understand and widely available thus it is the most common tool to detect abnormal colour vision. It has first plate which colour can be read by both normal and colour blind individuals. It is subsequently followed by 16 plates with colour coded numbers and patterns.

Unanimously Colour Vision Deficiency is more prevalent in males as compared to females. This is because genes encoding for red green colour is passed down through X chromosome and Males have only one X chromosome.

Prevalence of colour vision deficiency in European Caucasians is about 8% in men and 0.4% in women. In Chinese and Japanese, it ranges between 4% to 6.5%. However, there is marked difference in prevalence of colour vision deficiency in males and females of Europeans and Asian population.[6] Few prevalence studies have been reported from various regions of world. The estimated prevalence in Turkey is 7.3%, Iran 4.7%, India 2.8% to 8.2% (ethnic variations), Saudi Arabia 2.9%.[7,8] Colour vision deficiency reported from various areas of Pakistan has shown to be 5.1% in Rawalpindi, 1.41% in Karachi.[9] Hamida et al reported overall colour vision deficiency to be 2.48% in the population of Quetta and Siddiqui et al however found colour vision deficiency among Pakistani students from various institutions to be 2.75%.[10] These results are comparable to our study.

Colour blindness affects many people. Mostly they are unaware of this trait as reflected in our study. It is manifested only when they undergo detailed ophthalmic checkup. Specific jobs entities rely on normal colour perception and hence they get rejected. It renders them surprised to an extent that the person goes through an emotional setback. However behavioral therapies and aiding adaptation to daily life routine may help them.

Color vision defects also hamper health care workers in identifying general physical signs in body colour such as pallor, cyanosis, jaundice and erythema pertaining to life threatening diseases.[11]Ophthalmic and Otoscopic examinations or reading blood and urine test strips put them in confusing situation.[12,13] Unfortunately there is no modality yet discovered which can reverse colour blindness. These difficulties are under reported. It is due to the lack of screening before selecting or initiating profession in health care. Campbell determined that these health care providers

are a compromise to patients' safety.[14] Knowing of colour vision deficiency at earlier age can be helpful in selecting professions with less colour vision requirements. A study from Iran found that colour vision deficient laboratory technicians end up making errors in lab tests. They should not be considered medically fit for such employment choices.[15]

According to a report, 96% of the colour-blind students in middle school and 65% of the colour blind university students were totally unaware of their anomalous vision status.[16] In this study 94.52% of the candidates were unaware of their colour vision deficiency. This is comparable to an international study, which showed that 96% of colour blind students attending middle school were unaware of anomalous vision.[17] In another study it was found that 65% of the university students did not know about their anomalous vision.[18]

Congenital colour vision deficiency is non-progressive and incurable. Various therapies had been devised in the past like vitamin supplementation, electrical eye stimulation and iodine injection but those are ineffective.

Recent advances in technology has rendered user friendly applications in iPhone and iPad allowing colour blind person to see in improved way. Colour blind pal, colour filter, colour blind aid are the names of few such applications. There have been camera devices as well to aid colour blind individuals in their professions. Recently, advancement in genetic engineering has emerged with promising future. Few studies have been conducted on animals in which injecting a gene of missing photo pigment conferred colour vision. However, no such studies have been conducted on humans yet.[19, 20]

Screening of candidates or students make them aware of their limitations in power of colour observation hence enable them to device the ways to overcome them. This allows them to choose profession hence reducing anxiety and enhancing their confidence.

Limitation of this study is that it is a single center study, pedigree charts were not made and it did not take into account the type of color blindness.

CONCLUSION

The screened population showed colour vision deficiency to be present in 4.86% of the candidates and most of the individuals were unaware of their deficiency.

Ethical Approval

The study was approved by the Institutional review board/ Ethical review board. **(183/ERC/AFIO).**

Conflict of Interest

Authors declared no conflict of interest.

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Authors' Designation and Contribution

Summaya Khan; Consultant Ophthalmologist: *Concepts, Design, Literature search, Data acquisition, Manuscript editing, Manuscript review.*

Aisha Rafique; Trainee Ophthalmologist: *Concepts, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

Muhammad Azeem Khizer; Trainee Ophthalmologist: *Literature search, Data acquisition, Data analysis, Manuscript preparation, Manuscript editing, Manuscript review.*