Prevalence of Colour Vision Defect in the Indian Population - Results from a Pre-Employment Screening Centre of a Tertiary Care Hospital

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ABSTRACT

Introduction: Colour vision defect (CVD) is the inability to perceive colour differences under normal lighting conditions. Its prevalence, thought to be around 8% for men and 0.4% for women, vary from country to country, between regions in the same country, as well as between ethnic groups. Its importance lies in the fact that it prevents a person from carrying out certain jobs while creating difficulties in others. Screening for CVD during childhood and counselling to guide them towards choosing appropriate career needs to be carried out.

Material and methods: Records of pre employment screening from the period of 1st January 2016 to 30th June 2020 preserved in the Department of Medical Examination, of Atal Bihari Vajpayee Institute of Medical Sciences and associated Dr Ram Manohar Lohia Hospital were examined for the purpose of this descriptive study. Colour vision testing of candidates had been done using Ishihara's plates and interpreted using the instructions given with the plates.The number of candidates having CVD was tabulated according to age and gender. Calculations were done in MS Excel using formula for prevalence and confidence intervals were calculated using formula for population proprotion. Results were expressed as percentages.

Results: A total of 13179 candidates were screened during the period out of which 9879 were males (75%) and 3300 females (25%) with male to female ration of 3:1. 384 males (3.89%, 95% CI: 3.51%, 4.27%) and only 6 females (0.18%, 95% CI: 0.17%, 0.19%) were found to be colour vision defective giving a overall prevalence of 2.98%. There was an increase in the prevalence of colour vision defect after the age of 50.

Conclusions: In India, the overall prevalence of colour vision defects in males is 3.89% (95%CI 3.51%, 4.27%) and that of females is 0.18% (95% CI 0.03%, 0.32%). Screening for CVD at an early age will be beneficial for children and help them to choose their career in light of their deficiency.

Keywords: Colour Vision Deficiency, Protanopia, Deuteranopia, Triatanopia, Gene Therapy, Pre-Employment Screening.

INTRODUCTION

Colour vision defect (CVD) may be congenital or acquired. It is usually evaluated by Ishihara's colour plates or computer based software programmes.[1] The commonly quoted figures of CVD are 8% in males and 0.4% in females, though the prevalence varies from country to country, region to region, and even between population groups (Table 1). Cultural practices like consanguineous marriages are an important factor in the prevalence as congenital CVD is transmitted as an X-linked recessive condition.[2]

CVD is commonly congenital and is of three types, namely protan (red, long wave), deuta (green, middle wave), and tritan (blue, short wave).[3] However, colour blindness can also be secondary to ocular and intracranial pathologies, diseases like diabetic retinopathy, hypertension, glaucoma, macular degeneration, and yellowing of the lens owing to ageing[3] and drugs.[4]

The early detection of CVD is necessary for the person to choose the career option commensurate with his colour vision or lack of it. Some occupations like in transport, electrical industries, armed forces, as well as technical jobs like software programming require normal colour vision, though the criteria of requirement of normal colour vision for obtaining license for driving has been recently relaxed by the Government of India.[5] Besides, persons with CVD face difficulty in their personal activities like dressing, home decoration etc.

The criteria for fitness for jobs in the Government of India vary from post to post and also as to whether the post is gazetted/ non-gazetted or technical/non technical.[6,7] However, grey areas exist in areas like Medical Education, where those with CVD face difficulties in some subjects like histology, pathology, haematology, microbiology, dermatology, paediatrics, medicine, biochemistry and during ophthalmoscopy.[8] The case for screening of medical professionals have been made time and again[3,9] as also the psychosocial aspects and the need to balance concerns about patient care and the rights of doctors with CVD.[10] The Government of India specifies requirements for colour vision for some specialities for doctors in government service.[11]

The prevalence of CVD in various studies conducted in India varies from as low as 1.69% to 8.73% in males and 0.184% to 1.69% in females (Table 1). These studies were mostly conducted in small regions or among ethnic groups and hence this becomes their limitation. No studies are available encompassing wider and more variable population

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or regions. Our study fills this gap as candidates selected for jobs in the Government of India not only are from all over the country but also from all strata of society, and thus more representative of the population as a whole, providing a more cosmopolitan sample for this study.

MATERIAL AND METHODS

This descriptive study was carried out in the Atal Bihari Vajpayee Institute of Medical Sciences and associated Dr Ram Manohar Lohia Hospital, New Delhi, India. Permission from the Institutional Ethics Committee was taken for the study. The records of medical examination of candidates who undergo pre-employment screening are preserved in the Department of Medical Examination. The medical records of candidates who underwent pre-employment screening from the period of 1st January 2016 to 30th June 2020 in the Department of Medical Examination were examined for purpose of the study. Candidates who are selected for various posts, during their pre-employment screening,are also tested for their vision, including acuity and colour vision in addition to undergoing general and systemic physical examination. Colour vision of the candidates is tested by Ishihara's plates in a room with adequate daylight. The plates are held at a distance of 75 centimeters (cm) from the candidate and positioned perpendicular to the line of vision of the candidate. Candidates have to identify the numerals on the plates within 3 seconds. Interpretation as to whether a candidate is having CVD or not is done according to the instructions provided along with the plates. Candidates with CVD are marked as such in their medical records. The total number of candidates and those with CVD were tabulated according to the age and gender in MS Excel.

Calculations were done using MS Excel. Calculations were done and expressed separately for both genders. The total, age group, and gender wise prevalence of CVD in our sample were calculated using the formula Prevalence = Number of

Sl No	Study By	Place	Sample size	Results	Age
1	Reddy AVP et al[15]	Guntur Andhra Pradesh, India	1629	Males- 1.71% Females- 0.184%	School children 10-15 yrs
2	Karim KJ et al[16]	Erbil, Iraq	1856	Males -8.47% Females- 1.37%	7-25 yrs
3	Wale MZ et al[17]	Gish Abaya, Ethiopia	850	Males-3.18% Females- 1.06%	8-18 yrs
4	Woldeamanuel GG et al[18]	Wolkite, South Ethiopia	844	Males-3.65% Females-0.6%	11.75 (± 2.5) years
5	Rajavi Z et al[19]	Iran	2160	Males-3.5% Females -1.0%	7-12 years
6	Moudgil et al[20]	Punjab, India	3259	Males-1.69% Females- 0.184%	6-15 years
7	Hashemi H et al[21]	North east Iran	3132	Males- 15.85% (95% CI 13.26-18.44) Females- 12.96% (95% CI: 11.22-14.71)	31.54 ± 16.9 years (Range, 7-90 years)
8	Niroula DR et al[22]	Pokhara, West Nepal	964	Males- 3.8% Females-0%	10-19 years
9	Aprioku IN[23]	Nigeria	1000	Males-2.15 Females-0.7%	14.3±1.8 years Range 9-20 yrs
10	Chhipa AS et al[24]	Karachi, Pakistan	3437	Males-1.4% Females-0.4%	29.01 ±6.53 years
11	Hamida et al[25]	Quetta, Pakistan	1450	Males- 5.75% Females- 1%	5->64
12	Oriowo et al[26]	Saudi Arabia	1638	Males-5.85% Females-0.75%	6-19 years
13	Chia et al[27]	Singapore	1249	Males- 5.3% Females- 0.2%	13-15 years
14	Modarres M et al[28]	Tehran, Iran	2058	Males-8.18% Females-0.43%	12-14 years
15	Shah A et al[2]	Manipur, India	2654	Males-8.73% Females-1.69%	Adults, different populations
16	Fareed M et al[29]	Jammu, India	1028	Males-7.52% Females- 0.83%	6-15 years Different populations
17	Present study	India	13179	Males- 3.89% (95% CI: 3.51, 4.27) Females- 0.18% (95% CI: 0.03, 0.32)	28 ± 6.79 years Range: 18-62 years

Table-1: Showing comparison of different studies on CVD along with the present study.

Age	Total number of male candidates	Number of males with CVD	Prevalence (%)	Total number of female candidates	Number of females with CVD	Prevalence (%)
<20	82	2	2.44	17	0	0
20-29	7545	299	3.96	2651	5	0.19
30-39	1549	54	3.49	413	0	0
40-49	428	14	3.27	181	0	0
50-59	268	15	5.81	35	1	2.86
>59	17	0	0	3	0	
Total	9879	384	3.89	3300	6	0.18

Table-2: Prevalence of CVD in males and females of different age groups

candidates having CVD X 100/ Total number of candidates. The proportion of candidates having CVD were expressed in percent (%). 95% Confidence Intervals(CI) were calculated using the formula of CI for population proportion and the upper and lower limits expressed in percentages.

RESULTS

Records of a total of 13179 candidates were examined. The numbers of male candidates were 9879 and that of female candidates was 3300, with male to female ratio of 3:1.The average age of the candidates was 28 ± 6.79 years with median age being 20.77 years (IQR 20.13-21.42). The youngest candidate was 18 years of age while the oldest was 62 years of age.

Overall 3.89% of male candidates had CVD (95% CI: 3.51%, 4.27%) while the corresponding figure in females was 0.18% (95% CI: 0.04%, 0.32%). The age wise prevalence is also given in Table 2.

Out of the six female candidates who were found to have CVD, one candidate was declared unfit for the permanent job of 'Research Associate' and another candidate was declared 'fit' only for a temporary job of Residency, and not for permanent 'technical' job. Similarly, out of the 384 males with CVD, 31 candidates were declared unfit for their permanent jobs which were 'technical' in nature, while another 71 were found fit for 'temporary' jobs only and not for 'permanent' technical jobs. All of these 71 candidates were doctors and they would not qualify for permanent jobs in public sector related to different surgical specialities, as well as Pathology, Microbiology, Histopathology, Biochemistry, Radiology, Cardiology, which require high grade colour vision.[11] The rest of the candidates of both genders were declared fit as their employers did not require normal colour vision in those selected.

One male candidate of 54 years had concurrent Diabetes Mellitus, and another male candidate of 38 years had concurrent hypertension. The lone female candidate in the age group 50-59 was 54 years of age but had no concurrent illness. None of them had been tested for colour vision previously.

DISCUSSION

Colour Vision Deficiency is not a very rare condition. But it remains unnoticed by the person till it is detected. To the best of our knowledge, there are no screening programs in any country to detect CVD in their population, especially school children. A review by Ramachandran N et al[12] framed with respect to Wilson and Jungner criteria for screening programs[13] argued against routine colour vision screening in schools as CVD has not been shown to increase risk of road traffic accidents or affect the levels of educational achievements. At the same time, it cannot be denied that 'normal' colour vision requirements are a part of many occupations, especially those considered 'technical' in nature or even in occupations like fashion designing, in which colours play an important role. Besides, standards of fitness for many jobs in the public sector necessitate presence of normal colour vision. The psychological impact of a candidate being denied such a job as he is for the first time detected to have CVD is devastating. Besides, such denial invariably results in complaints, and litigation. This favours the case for screening for CVD, so that children and parents can be guided and counselled as to future career plans.

Most studies both in India and abroad have focused on particular populations or regions. They have been summarized in Table 2. Most of them with few exceptions have been carried out on children and / or young adults. Our study encompasses a wider range of age from 18 to 62 years. As has been mentioned before, the sample in addition to being larger is more representative of the population as a whole.

Although not significant in absolute terms, the prevalence of CVD in those above 50 years of age showed a slight increase in proportion. As has been mentioned before, only one male among them had diabetes (well controlled) and the lone female candidate had no known concurrent illness. The physical examinations carried out during the pre-employment screening too had not detected any abnormality. Since, a candidate has to have normal visual acuity with or without glasses and no end organ affection due to hypertension or diabetes in order to be declared fit for the job as per the criteria[6], and as these candidates had been declared 'fit', the reason of the slight increase in prevalence after the age of 50 cannot be commented upon, as none of them had ever been examined for CVD earlier. However, it can be assumed that the prevalence in excess of those below age of 50 is likely to be due to secondary causes. The prevalence of CVD in males below 50 years of age is 3.84% (95% CI: 3.46%, 4.22%), while those in females less than 50 years is 0.16% (95% CI: 0.03%, 0.29%) in our study. It can be safely assumed that

these figures represent the prevalence of congenital CVD and would have been detected had they undergone screening for CVD previously.

It is also to be noted that the candidates declared unfit for jobs which were 'technical' in nature and required presence of normal colour vision would have benefitted from screening at a younger age and they could have been advised right at the outset about the careers they could take up. Screening for CVD in childhood itself assumes more importance in view of the gene therapy for CVD which has succeeded in animal models, is undergoing human trials, and which will most likely have to be applied in childhood to be more effective[14].

The strength of our study is its large sample size, a sample which is more representative of the population, not bound by ethnicity and region, and which shows the prevalence in different age groups. The drawbacks are that it is a retrospective study with its inherent drawbacks, the CVD was not classified into high grade or low grade, or into protanopia, deuteranopia, or tritanopia. However, these classifications are not required by employers and would thus be superfluous in a pre-employment screening.

CONCLUSION

We conclude that CVD is not rare in the Indian population in general but mostly escapes notice due to absence of any screening program. Detected for the first time during a pre employment screen, it may mar the chances of getting a job if it requires normal colour vision. Knowledge about the CVD at an early age can help in choosing the proper career for a child as well as enroll in human trial for its treatment by gene therapy.

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