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COMPARISION OF TWO PSEUDOISOCHROMATIC TEST FOR DETECTION OF COLOUR VISION DEFFICIENCY: A CROSSECTIONAL STUDY

Ophthalmology

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ABSTRACT

BACKGROUND: Color vision is a function of three types of cone pigments which are present in retina. Any abnormality in these cone pigments may cause deficiency of color vision which is called as color vision deficiency. Our study was carried out to find out colour vision deficiency in secondary school children of solapur city.

MATERIAL AND METHODS: Two pseudoisochromatic tests, namely, ishihara test and Richmond HRR test for testing colour vision deficiency was used to identify children suffering from CVD. Period of study was from august 2016 to July 2018. 5,000 school children in Solapur city irrespective of their gender/ background /socio economic status aged between 10-15 years were included in the study.

RESULTS: Total number of students found out to be CVD according to Ishihara chart was 213 i.e. 04.26%, out of which 200 i.e. 06.19% were males and 13 i.e. 0.73% were females.CVD according to HRR chart was 215 i.e. 04.30%, out of which 202 i.e. 06.25% were males and 13 i.e. 0.73% were females.

CONCLUSIONS: Prevalence rate of CVD was found to be more in males and by using HRR test was slightly higher than Ishihara test. Tritanopia was detected by only HRR test which could not be detected using Ishihara test.

KEYWORDS

CVD, Ishihara test, HRR test.

INTRODUCTION:

The colour vision deficiencies have a high prevalence and the reported prevalence of colour vision defects (CVD) is about 8% in males and 0.4% in females. But one fifth to one third adults are unaware of their colour deficiency as their vision is otherwise normal[1]. Colour vision defect may be congenital or acquired. Congenital defects are X-linked and acquired deficiencies are caused by ocular pathologies and drugs[3]. The first case on record was discovered in the practice of Dr. Tuberville in 1684. Nearly a hundred years later an English chemist by the name of Dalton, who was colour blind himself, published the first accurate description of the condition[4]. The Ishihara colour test is a test to determine if a patient has colour blindness. It was named after Dr. Shinobu Ishihara who first published the test in 1917 as a professor at the University of Tokyo[5]. It is the most widely used screening test for red-green colour deficiency[5]. The HRR pseudoisochromatic test was developed by Hardy, Rand and Rittler and was first published by the American Optical Company in 1955[6]. The HRR provided the clinician with more information than the Ishihara in a test that was just as easy to administer[6]. The Ishihara test, renowned for its high sensitivity and excellent specificity for the detection of protan and deutan deficiencies, has no tritan plates and the number of errors made gives little indication of severity[6]. Richmond Products published a further edition of HRR test in 2002, the colours of which have been carefully re-engineered with the assistance of Jay and Maureen Neitz and James Bailey[6]. Colour vision deficient individuals have difficulty in comprehension because of increased reaction time[5]. Unfit for certain jobs like traffic policemen, defense personnel, electrician, electronic engineer, artist which require proper perception of colours which may lead to lesser efficiency in work as well as may cause accident[5].

AIM AND OBJECTIVES:

To find out the prevalence rate of CVD and classify them. Comparison of results in respect of Ishihara's test and HRR test.

MATERIAL AND METHODS:

Study area: Present study has been carried out in secondary schools of Solapur city. Total 138 such schools in Solapur city with enrolment of 28,467 students[7]. Study design: community based cross Sectional study. Period of study: august 2016 to July 2018 i.e. 24 months. Sampling frame: consisting of students of std five to std tenth in Solapur city. **Prevalence of colour vision deficiency in India is 8%[5].** The sample size was estimated by using formula at 95% Confidence interval.

$N = (1.96)^2 \times p \times q / L^2$, $N = 3.84 \times 8 \times 92/(0.8)^2 = 2944/64 \times 100$

$N \approx 4600$

So, sample size taken as 5,000. We took approval and permission from respective school principal. Informed consent was taken from parents and guardians. The students were tested for colour vision deficiency using Ishihara's Type Tests for colour Blindness, 38 Plates Edition & new 4th edition of the HRR test, produced in 2002 by Richmond Products. The colour vision testing plates was held at **75 cm** from the student and tilted at right angle to the line of vision. The test was done in adequate lighted room resembling natural day light. Students were asked to read the numbers seen on the test plates and answer was noted down. The time given for telling the number on a plate was 5 sec. Appropriate Statistical tests were applied.

Inclusion criteria:

- Healthy students with normal ocular examination findings.
- Students' age between 10-15 years.
- Students willing to participate in the study.

Exclusion criteria:

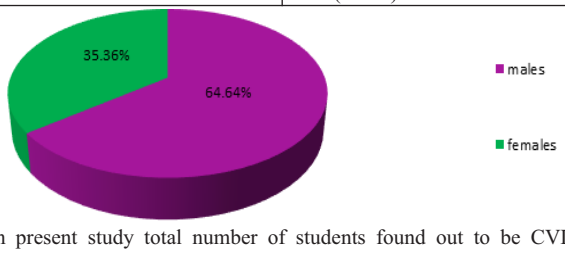
- Chronic drug therapy (more than one month).
- Students not willing to participate in the study.

RESULTS:

The present community based cross-sectional study was carried out among 5,000 school children in Solapur city irrespective of their gender/ background /socio economic status. Out of which 3232 were males and 1768 were females.

Table No. 1: Distribution of Students according to Class.

Class	Students examined
Std V	1242 (24.84%)
Std VI	996 (19.92%)
Std VII	940 (18.80%)
Std VIII	770 (15.40%)
Std IX	563 (11.26%)
Std X	489 (09.78%)
Total	5000 (100%)



In present study total number of students found out to be CVD according to Ishihara chart was 213 i.e. 04.26% and CVD according to HRR chart was 215 i.e. 04.30%.

Table no 2: comparison of Colour vision deficient students detected by Ishihara and HRR chart.

Class	CVD students detected by Ishihara chart	CVD students detected by HRR chart
Std V	70 (32.86%)	70 (32.55%)
Std VI	50 (23.47%)	50 (23.25%)
Std VII	34 (15.96%)	35 (16.27%)
Std VIII	27 (12.67%)	27 (12.55%)
Std IX	19 (08.92%)	20 (09.30%)
Std X	13 (06.10%)	13 (06.04%)
Total	213 (100%)	215 (100%)

$\chi 2 = 0.031$, df = 5, $\chi 2 < 0.05$, association is significant

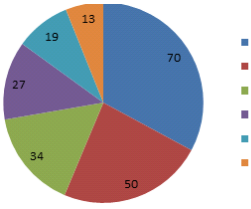


Fig 2: CVD students by Ishihara chart

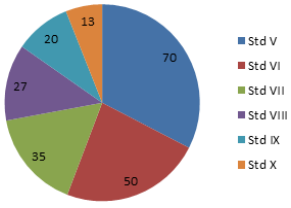


Fig 3: CVD students by HRR chart

In the present study according to Ishihara's test deutan CVD was found out to be more prevalent affecting 148 i.e. 69.49% students who are examined compared to protan CVD which was found to affect 65 i.e. 30.51% students. According to **HRR test** deutan CVD was found out to be more prevalent affecting 148 i.e. 68.83% students who are examined compared to protan CVD which was found to affect 65 i.e. 30.23% students. Tritanopia was found in 02 i.e. 00.93% students. Tetartan CVD was not detected.

Table no 3: Comparison of types of Colour vision deficient students detected by Ishihara and HRR chart. *NA- not applicable

Type	CVD students detected by Ishihara chart	CVD students detected by HRR chart
Protan	65 (30.51%)	65 (30.23%)
Deutan	148 (69.49%)	148 (68.83%)
Tritan	NA*	02 (00.93%)
Tetartan	NA*	00 (00.00%)
Total	213 (100%)	215 (100%)

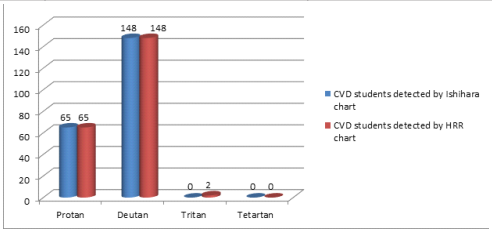


Fig 4: Comparison of Colour vision deficient students detected by Ishihara and HRR chart.

According to Ishihara's test mild CVD was found out to be more prevalent affecting 174 i.e. 81.69% students who were examined compared to strong CVD which was found to affect 39 i.e. 18.31% students. According to HRR test mild CVD was found out to be more prevalent affecting 142 i.e. 66.05% students who were examined compared to moderate CVD which was found to affect 52 i.e. 24.19% students and severe CVD which affected 21 i.e. 09.77% students.

Table no 4: Comparison of degree of Colour vision deficient students detected by Ishihara and HRR chart. *NA- not applicable

Degree	CVD students detected by Ishihara chart	CVD students detected by HRR chart
Mild	174 (81.69%)	142 (66.05%)
Moderate	NA*	52 (24.19%)
Severe	39 (18.31%)	21 (09.77%)
Total	213 (100%)	215 (100%)

The chi-square statistic is 13.5529. The p-value is 0.000232. The result is significant at $p < 0.05$.

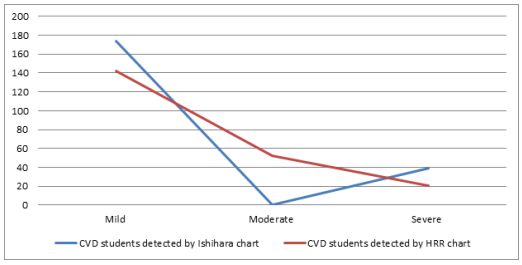


Fig 5: Comparison of degree of Colour vision deficient students detected by Ishihara and HRR chart.

DISCUSSION:

Contents		Present study	Arpan chakrabarti et al8	Md. Fareed et al9	Ahsana et al10
Prevalence	Ishihara	04.26%	04.06%	04.38%	05.28%
	HRR	04.30%	-------	-------	-------
Ishihara types	Protan	65 (30.51%)	12 (40.00%)	10 (23.80%)	37 (29.36%)
	Deutan	148 (69.49%)	18 (60.00%)	32 (76.20%)	89 (70.64%)
HRR type	Protan	65 (30.23%)	----------	-------	-------
	Deutan	148 (68.83%)			
	Tritan	02 (00.93%)			
	Tetartan	00 (00.00%)			
Ishihara degree	Mild	174 (81.69%)	17 (56.67%)	29 (69.05%)	83 (65.87%)
	Severe	39 (18.31%)	13 (43.33%)	13 (30.95%)	43 (34.13%)
HRR degree	Mild	142 (66.05%)	---------	-------	-------
	Moderate	52 (24.19%)			
	Severe	21 (09.77%)			

The Richmond HRR can be used confidently to detect red green colour vision deficiency and is as good as the Ishihara in doing this. In addition, it is reasonable to assume that it will detect tritan deficiencies, which the Ishihara does not. The HRR is not as well known as the Ishihara, so the risk of persons learning the correct answers to enable them to pass the test is very small and in any case the HRR can be presented upside down to confound those who have been industrious enough to learn the correct answers.[6]

CONCLUSION: In the present study prevalence rate of CVD was found to be more by HRR than ishihara chart. According both ishihara and HRR chart Deutan CVD was more prevalent than Protan CVD. Using Ishihara's test mild degree of CVD was more prevalent than severe degree; similarly using HRR test mild degree of CVD was more prevalent than moderate and severe degree. Tritanopia was detected by only HRR test which could not be detected using Ishihara test.

RECOMMENDATION: Color vision deficiency is currently under-diagnosed as the screening for color vision deficiency is not well appreciated and even Ophthalmologists neglect this aspect of vision. Increasing the awareness about color vision deficiency and its impact on various stages of life. Genetic counseling in the regions with high prevalence of color vision deficiency will decrease the birth of children with this deficiency. Population based screening for color vision deficiency is one of the most important steps to initiate appropriate measures and plan adaptive strategies. Test for color vision should be a part of ophthalmic examination. There are number of putative methods which may help in correcting color vision deficiency like (i) Tinted spectacles or contact lenses, (ii) Notch or band pass filters, (iii) Eyeborg and (iv) Gene therapy.[11]

Disclosures: The conflicts of authors disclose no potential interest. There is no financial interest behind this study.

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