

Incidence Of Color Blindness Among Some Endogamous Groups Of Bathinda District, Punjab

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Abstract

To find out the incidence of sex-linked defective color vision in people of Bathinda district in southern Punjab, a survey was planned among the school going boys using standard Ishihara's Color Plates Chart. The present study was conducted on a total of 1,002 individuals belonging to 9 caste, 11 backward caste and 5 scheduled caste endogamous groups, as well as a few from Muslim and Christian religious groups. In the total individuals screened as many as 34 cases of red-green color blindness and 3 of total color blindness were detected. All the red-green color blind subjects were found to be of deutan type, comprising 8 strong and 26 mild cases. No protan individual was detected in the present survey. Of the 27 endogamous groups tested, 16 groups showed absence of the trait while the incidence in remaining groups of the castes, backward castes and schedule castes were in rather similar and broad ranges between 0 to 6.7%, 0 to 6.3% and 0 to 4.7% respectively. Besides, in each of these 3 caste groupings, 1 total color blind subject was found. Compared to some initial studies on color blindness available from Punjab (average 5.2%), the present and some other recent surveys provide comparatively lower estimates of all trait (average 3.22%) which is found to be very close to that of U.P. (3.28%) and Delhi (3.15%) suggesting similarities in this genetic trait among populations of these states of the region. While in 249 populations on the North-Western Indian region so far tested the average incidence of color blindness was calculated to be 3.98%. To fully appreciate the true variation of this genetic trait and also to complete the genetic map of people of people of Punjab, further studies, are required.

INTRODUCTION

Unevenly distributed over the retina of the normal human individual's eye are several light sensitive elements called rods and cones. The cones, millions in number, are predominant in central part of the eye while the rods, hundreds of millions in number, are predominant in the peripheral region of the eye. Rods are responsible for the vision in the dark and can not provide any color discrimination. Cones, conical as they are in shape unlike the cylindrical rods, contain rhodopsin, a substance sensitive to light. Cones are responsible for the actual vision in bright light and color vision¹. Normally, there are three kinds of cones, each containing a different pigment, which are activated when the pigments absorb light. The technical names for these receptors are S-cones, M-cones, and L-cones, but they are also often referred to as blue cones, green cones, and red cones, respectively. The absorption spectra of the cones differ; one is maximally sensitive to short wavelengths, one to medium wavelengths, and the third to long wavelengths, with their peak sensitivities in the blue, yellowish-green, and yellow regions of the spectrum, respectively. The absorption spectra of all three systems

cover much of the visible spectrum.

A person having normal vision will need a particular intensity ratio of red green and blue primary colors to see white; he is normal trichomate. Some individuals, however need more of one of the primary colors than the other two; these are anomalous trichomates. Nearly as many persons need only two primaries to see white; these are dichromates. A very few people can match a white light with just one primary color; these are monochromates or achromates and they perceive no hues and see only white or grey. So, these persons who are unable to distinguish certain colors are called colorblind. Several types of color blindness are known but the most common one is Red-Green color blindness. It has been described by Horner as early as in 1876². Color blindness can be classified into following three main categories:

1. 1. Anomalous Trichromates (need more of 1 of 3 primaries And less of other 2 to see white light)
 - a. a) Protanomalopia (mild red blind)

- b. b)Deuteranomaliamild green blind)
 - c. c)Tritanomaliamild blue blind)
 - d. d)Protanopia(absolute strong red blind)
 - e. e)Deuteranopia(absolute strong green blind)
 - f. f)Tritanopia(absolute strong blue blind)
3. 2. Dichromates (use only 2 of 3 primaries to see white light (And lack 3rd pigment)
4. 3. Monochromates(have only 1 of 3 primaries-total color blind)

Color blindness is one of the common genetic disorders observed in all human populations. The color blindness is a recessive genetic trait expressed due to presence of a defective gene present on sex-chromosome X, thus called X-linked or sex-linked trait. The genes are located on the X chromosome within the Xq28 band³. Another study with the help of DNA hybridization confirmed that the genes for red-green deficiency are on X chromosomes & is used as a genetic marker to study human diversity⁴. The fact that color blindness is so much more prevalent among men implies that, like hemophilia, it is carried on the X chromosome, of which men have only one copy (As in hemophilia, women are protected because they have two X chromosomes a normal gene on one chromosome can often make up for a defective gene on the other.) It is criss-cross inheritance as males express the trait while females only transmit it. Thus, this color vision anomaly is widely used as a genetic marker in the study of human variation in various ethnic groups of India^{5,6} and is frequently cited as 'relaxed selection' according to the Post and Pickford hypothesis^{7,8}.

Investigators such as Post, Dutta and Salzano^{7,9,10} and many others have proposed that the ratio of color-blindness is higher in agricultural and urban populations than those of hunters and food gatherers. According to them this is due to the effect of relaxed selection against color-blindness in the former group as compared with the latter. In reviewing the data on color-blindness in Indian populations, Kapoor et al.¹¹ found a gradual decrease in the frequency of color-blindness from settled agriculturists and urban communities through semi settled primitive agriculturists to hunters, food gatherers and nomads.

The frequency of color-blindness is around 8 % among

Europeans. It is between 1 and 6% with an average of 4 % among Africans ; between 2 and 7% with an average of 5.6 % in South-West Asian populations; between 3 and 6% in populations of East Asia and South-East Asia and about 1% among South American Indians and Eskimos¹². The incidence of red-green color blindness among Europeans and American Whites (range 7-8 %) is greater than that among American Indians and Australian aborigines (range 2-3%)¹³.

MATERIALS AND METHODS

For this survey a total of 1,002 school going boys of 5th to 12th standards in six educational institutions and belonging to 9 Caste, 11 Backward Caste and 5 Scheduled Caste endogamous groups, as well as a few from Muslim and Christian religious groups, of Bathinda district were screened using standard Ishihara's Color Plates Chart¹⁴. Care was taken to exclude closely related individuals i.e. in case of two brothers studying in a school only 1 was considered. All subjects were permanent residents of Bathinda district and no other individual temporarily staying in district was included. Since, the studied trait is sex-linked and females are rarely affected, girl students of these schools were not considered in this investigation. Due to large sample size, Ishihara test was simplified to an examination of 6 plates only i.e. plate number 1 and one each of Plate number groups 2-5, 6-9, 10-13, 14-17, and 18-21. Persons unable to read these 6 plates correctly were asked to read all the Plates 1 to 25 and each of their readings were recorded.

RESULTS AND DISCUSSION

Results are presented in table 1. In the total 1,002 individuals screened, as many as 34 cases of red-green color blindness and 3 of total color blindness were detected, giving a combined incidence of 3.7% for color blindness in district. All the red-green color blind subjects were found to be deutan (green-blind) type, comprising 8 strong and 26 mild cases. No protan (red-blind) individual was detected in the survey. This table shows that the out of 34 red-green color blind subjects detected in this survey, as many 10 were found in the Bania, giving an incidence of 4.2% of color-blindness in this caste group. In addition, a Total color-blind individual was also encountered in them. In other caste groups studied viz. the Khatri, Jat, Sikh, Brahmin, Rajput, Arora, Jain, Saini and Suniyar, the incidence of red-green color blindness varied from nil in Jain, Saini, Suniyar to a high of 6.7% in the Arora. Among the 11 Backward caste groups of this study, as many as 9 showed complete absence of the trait. Of the remaining two B.C. groups, the Ramgharia showed an incidence of 6.25% for red-green color blindness

and the Chhimba 3.12% for Total color blindness. As for the 5 Scheduled Caste groups studied, 3 showed an incidence of red-green color blindness in the range of 3.12% - 6.12% and a Ramdasia subject was found to be Total color blind. Thus, among subjects of the three social groupings examined here from Bathinda district of Punjab, the occurrence of color blindness was found to be highest among the Caste groups (6.7%), followed by Scheduled Castes (6.0%) and Backward Castes (1.8%) while the Christians And Muslims lacked the trait completely.

In short, of the 27 endogamous groups tested, 16 groups showed the absence of red-green colorblindness while the incidence in the remaining groups of Castes, Backward Castes and Scheduled Castes were in rather similar and broad ranges between 0 to 6.7 %, 0 to 6.3% and 0 to 4.7% respectively. Thus, apparently there appear to be some caste differences in occurrence of red-green color blindness in the people of Bathinda district and the Scheduled Caste showed the lowest value. However, the distribution of Total color blindness was uniform-one such subject was encountered in each of these three social groupings. Many of the groups studied have showed the absence of red-green color blindness which could be attributed to their small sizes, this in fact roughly reflected their actual proportions in the contemporary population of Bathinda district.

Compared to some initial studies on this genetic trait which were limited only to three studies of Chattopadhyay, Bansal and Mitter and Bhanwer et al.^{15,16,17}, available from Punjab (average 5.2%), the present (3.7%) and some other recent large scale surveys such as those of kaur from Gurdaspur district (3.1%), Franky from Muktsar district (3%), Nisha from Sangrur district (2.4%), Kaur from Rupnagar district (4%),Nag from Ludhiana district (3.7%) provide comparatively lower estimates of the trait (average 3.22%) which was close to that of U.P (3.28%) and Delhi (3.15%) suggesting similarities in this genetic trait among populations of these states in the region^{18,19,20,21,22}.

Table 2 lists the Average Incidence of color blindness in various States/Union Territories of North-West India. This table shows that of the 27,399 subjects examined so far from 249 population groups, a total of 1,090 individuals was found to be color blind, giving an overall frequency of 3.98% for occurrence of the genetic trait in the entire region. However, the people of North-East India are found to be extremely variable with regard to this trait, the frequency ranging from 0 - 8.05%²³. Also, there was great variation in the average incidence and the minimum was recorded in the

people of Haryana (1.58%) and maximum (6.95%) in some populations sampled from both Uttar Pradesh and Rajasthan. But on the other hand, comparatively higher values were observed for the neighbouring urban union territory of Chandigarh (5.44%) and state of Jammu and Kashmir(4.53%).Furthermore, this table shows the average incidence of color blindness in himachal Pradesh to be 2.77% which is quite close to a recent study done on students in urban area of shimla in North-west Himalayas viz.2.3%²⁴ and also to Sangrur district in Punjab i.e. 2.4%²⁰. Nonetheless, to fully appreciate the distribution of color-blindness in people of Punjab, further studies, preferably by anomaloscopic tests, are required. Such an approach will better help in assessing the validity of the Post- Pickford Hypothesis of relaxed selection in this part of country.

Figure 1

Table 1. Incidence of Colour Blindness in different endogamous groups of Bathinda district in Punjab, North-West India.

Endogamous Group	Number tested	Red - Green Colour Blindness						Total	Total Colour Blindness
		Deutan			Protan				
		Strong	Mild	Total	Strong	Mild	Total		
Arora	45	-	3	3(6.7)	-	-	-	3(6.7)	-
Bazigar(B.C.)	5	-	-	-	-	-	-	-	-
Baimoi(S.C.)	25	-	-	-	-	-	-	-	-
Bania	241	2	8	10(4.2)	-	-	-	10(4.2)	1(0.4)
Brahmin	100	2	3	5(5.0)	-	-	-	5(5.0)	-
Chhimba(B.C.)	32	-	-	-	-	-	-	-	1(3.1)
Chrosan	1	-	-	-	-	-	-	-	-
Dakot(B.C.)	2	-	-	-	-	-	-	-	-
Dhanak(B.C.)	22	-	-	-	-	-	-	-	-
Jain	9	-	-	-	-	-	-	-	-
Jat Sikh	87	-	2	2(2.3)	-	-	-	2(2.3)	-
Khatn	74	-	1	1(1.4)	-	-	-	1(1.4)	-
Kumhar(B.C.)	27	-	-	-	-	-	-	-	-
Kurmi(B.C.)	4	-	-	-	-	-	-	-	-
Lohar(B.C.)	7	-	-	-	-	-	-	-	-
Mazhab Saini(S.C.)	49	1	2	3(6.1)	-	-	-	3(6.1)	-
Mehra Sikh(B.C.)	5	-	-	-	-	-	-	-	-
Muslim	5	-	-	-	-	-	-	-	-
Nai(B.C.)	5	-	-	-	-	-	-	-	-
Parajapati(B.C.)	10	-	-	-	-	-	-	-	-
Rajput	90	1	3	4(4.4)	-	-	-	4(4.4)	-
Ramdasia(S.C.)	85	1	3	4(4.7)	-	-	-	4(4.7)	1(1.2)
Ramgahai(B.C.)	16	1	-	1(6.3)	-	-	-	1(6.3)	-
Navdasia(S.C.)	32	-	1	1(3.1)	-	-	-	1(3.1)	-
Saini	12	-	-	-	-	-	-	-	-
Suniyar	9	-	-	-	-	-	-	-	-
Vinayg Saini(S.C.)	2	-	-	-	-	-	-	-	-
Total	1002	8	26	34(3.4)	-	-	-	34(3.4)	3(0.3)

Figures in parentheses are percentages.

Figure 2

Table 2. Average incidence of Colour-Blindness in different States/Union Territories of North-West India.

State/Union Territory	Number of Population Groups	Total number Tested	Color Blind (Red-Green deficient)
Jammu and Kashmir	18	3289	149(4.53)
Himachal Pradesh	36	3964	110(2.77)
Punjab	111	6642	214(3.22)
Chandigarh	3	1582	86(5.44)
Haryana	16	1961	31(1.58)
Delhi	16	2607	82(3.15)
Punjab & Delhi	1	217	10(4.61)
Uttaranchal	18	3092	114(3.69)
Uttar Pradesh	23	2528	83(3.28)
Rajasthan	4	237	4(1.69)
Uttar Pradesh & Rajasthan	4	1280	89(6.95)
North-West India	249	27399	1090(3.98)

Figures in parentheses are percentages.

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