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COLOR BLIND PREVALENCE OF ELEMENTARY STUDENT IN SUMBERSARI SUBDISTRICT, JEMBER

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ABSTRACT

Red-green color blindness is the most common type of color blindness. Color blindness disorders occur due to genetic factors determined by the recessive gene c (color blind) which is linked to the X chromosome. This study aims to determine the prevalence and frequency of color-blind alleles and to determine the pattern of inheritance of color-blind genes by conducting pedigree analysis on color blindness students' family. The research was conducted in 13 public elementary schools, Sumbersari subdistrict, Jember Regency with a multistage cluster sampling method of sampling with a total sample of 286. Detection of color blindness using Ishihara's methods. Based on the results of this study, the color blindness prevalence of elementary school students in Sumbersari subdistrict, Jember was 2.79% with the prevalence in males and female were respectivelyas 4.86% and 0.7%. The allele frequency of color blindness was 0.021 and the normal allele frequency was 0.979. The pedigree analysis of a color-blind student family shows the gene of color blindness is inherited in a criss-cross inheritance pattern.

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1. INTRODUCTION

Color blindness or color vision deficiency (CVD) is an ocular disorder that hinders the patients from distinguishing shades of certain colors. The most common form of color blindness is red-green, which is a result of either a missing or defective red or green photoreceptor cone (Salih et al., 2020). Color blindness can occur due to genetic factors. The gene for color blindness is carried by the X chromosome, while the Y chromosome does not carry the gene for color blindness. This has resulted in genotype differences between female and male color blind people (Anwar & Hutagalung, 2018).

In general, color blind people can be classified into 2 types, i.e total color blindness and partial color blindness. Total color blindness is a person has only one or none of the color pigments so that the patient can only see black, white and gray (Dhika et al., 2014). One example of partial color blindness is red-green color blindness (Husain et al., 2020). Some people with red-green color blindness will have difficulty distinguishing the color gradations between red, green and yellow such as brown and orange. Red-green color blindness is the most common type of color blindness compared to other types (Gupta et al., 2017).

The prevalence of color blindness varies in each population, generally affecting more men than women. The research result in Europe shows the prevalence of color blindness in men was 8-12% and in women 0.5-1% (Birch, 2012, Octaviano and Umbari, 2017). Color blindness in East India was 7.52% for men and 0.83% for women (Fareed et al., 2015). In Singapore, the color blind was 5.2% for men and 0.2% for women (Franzco et al., 2008). In southern Ethiopia, 3.6% of men have color blindness and 0.6% of women (Woldeamanuel & Geta, 2018).

The prevalence of color blindness in Saudi Arabia in men is 3.5% and in women 0.5% (Khairoalsindi et al., 2019). The research result of color blindness in Indonesia, showed it was 2.9% in men while in women was 0.33% (Karolina et al., 2019; Wahyunita & Armajin, 2019; Wulandari et al., 2020). Color blindness can be detected using Ishihara color blind test. This methods is quickly to detect color blindness disorders. The Ishihara test consists of a number of plates, where each plate contains dots of different sizes and colors. All dots on plates are arranged in specific patterns to form numbers or figures that people with normal color vision can see. (Ardiyan et al., 2019).

Color blindness is a disorder that does not cause physical abnormalities and is medically not psychologically threatening (Purwoko, 2018). However, color vision is very important for individuals in their visual and color-blind people will have difficulty in daily life when dealing with color (Woldeamanuel & Geta, 2018). In many cases they find out color blind after taking color blind test when applying for work or continue the higher school. The delay to find out this disorder can affect to choose their career (Karim & Saleem, 2013). Based on these cases, thus necessary to study on the prevalence and frequency of color-blind alleles of elementary students, in Sumbersari sub district, Jember. This study is important, order to elementary students and their parents to know early a color blindness thus they can prepare for educational and career in the future.

2. RESEARCH METHOD

Sampling Method

Sampling was carried out on 5th and 6th grade elementary school students in 13 elementary schools in the Sumbersari sub district, Jember, it was approximately 286 students. The sampling method used is the method multistage cluster sampling, i.e sample divided in many clusters and the sampling was gradually and randomly (Wale et al., 2018). Samples of Elementary schools in Sumbersari sub-district were randomly selected 13 primary schools out of 31 primary schools. Students in each class were taken by random sampling method.

Color Blindness Detection by Ishihara Test 14 Plate

Sampling was carried out following the procedure based on *Ethical Clearance* number 1232/UN25.8/KEPK/DL/2021. Detection of color blindness start by showing the Ishihara plate to students from plate number 1 to number 14. Students are asked to look at each *plate for* Ishihara approximately 10 seconds and are asked to name the number on the *plate* Color blindness test using the Ishihara method, can determine the the probandus condition. the normal probandus when they can read 8 or all of the Ishihara plates (14) correctly. The person who has red-green color blindness, they can only read 7 out of 14 plates. Total color blindness can be detected if the probandus can only read license plates 1 (Ishihara, 1994). The next step is to calculate the color blindness prevalence, allele frequency and the pedigree analysis of family color blind students.

Research Parameters

Calculation of the color blindness prevalence using the formula (Sumarni, 2010).

$$Color\ blindness\ Prevalence\ = \frac{Number\ of\ Colorblind\ Individuals}{Number\ of\ Research\ Samples} x100\%$$

According to Crow and Kimura (1970), the allele frequency was calculated using the Hardy-Weinberg formula.

$$(p+q)^2 = 1$$

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

Where p represents the frequency for the dominant gene C (normal allele) and q represents the frequency for the recessive gene c (color blind allele).

According to Fareed et al. (2015) calculation of male and female allele frequencies using the following formula:

1. Female color blindness

$$c\ = \frac{\sqrt{\%\ color\ blind\ phenotype}}{100}$$

2. Male color blindness

$$c\ = \frac{\%\ color\ blind\ phenotype}{100}$$

3. Male and female color blindness

$$c\ = \frac{1}{3} xc\ (l) + \frac{2}{3} xc(pr)$$

$$C\ =\ 1 - c$$

Where C is the normal allele frequency and c is a color-blind allele frequency

3. RESULTS AND DISCUSSION

Color blindness prevalence results of elementary student in Sumbersari subdistrict, it can be shown in table 1.

Table 1. Color blindness prevalence of elementary student in Sumbersari subdistrict.

Phenotype	Gender				Number of Samples	
	Male		Female			
	n	%	n	%	n	%
Color Blind	7	4.86	1	0.70	8	2.79
Normal	137	95.14	141	99.30	278	97, 21
Total	144	100	142	100	286	100

Table 1 shows that the prevalence of color blindness in elementary student in Sumbersari subdistrict, Jember was 2.79% the male and the female prevalence respectively were 4.86% and 0.70%. These results indicate that the color blindness prevalence of elementary student in Sumbersari subdistrict was smaller than the elementary student in Kaliwates subdistrict, Jember. The elementary student in Kaliwates subdistrict has 9.85% with prevalence of male and female were 18.63% and 1% (Ningrum, 2008). The research result of colorblindness in children of North India is 4.38%, with a male and female prevalence are 7.52% and 0.83% (Fareed et al., 2015). While the other reserach showed in elementary student in Gish Abay, Northwest Ethiopia has 4.24% with a male is 3.18% while a female is 1.06% (Wale et al., 2018). The elementary student in Koya, Iraq is 3.39% all in male and there was no colorblindness in female (Smail et al., 2019). This study showed the colorblindness in Sumbersari subdistrict was higher than elementary student in Badung Regency, Bali. In Bali has 2% with male and female are respectively 3.78% and female 0.22% (Karolina et al., 2019).

There are prevalence variations in red-green color blindness by population, race, tribe and ethnic (Karolina et al., 2019). The data showed that the number of male color-blind people is more than female color blind so that it can prove that color blindness is a disorder caused by the recessive gene c is linkage on X-chromosome (Nazeer et al., 2019). Males only have one X chromosome so that the color-blind gene will be easily expressed (Moudgil et al., 2016). Whereas women have two X chromosomes, when one of the alleles carries the color blindness gene, it will be covered by the dominant allele. Women who have one recesive allel c, are normal individuals but she is carrier (Singh & Chahal, 2009). Color blind women are individuals who have two recessive alleles of color blindness or their genotype is recessive homozygous (Shah et al., 2013).

The frequencies of color blind and normal alleles were calculated using the Hardy-Weinberg formula. The allele frequency calculation results are shown in Table 2.

Table 2. Allele frequencies color blind and normal of elementary students in Sumbersari Subdistrict

allele	Gender		Total
	Male	Female	
Color Blind (c)	0,048	0,008	0,021
Normal (C)	0.952	0.992	0.979
Total Frequency Allele	1	1	1

Table 2 shows that the allele frequency of color blind in elementary student of Sumbersari subdistrict, Jember was 0.021. The color-blind allele frequency of male and female were respctively were 0.048 and 0.008. This allele frequency of color blind is lower than the children of North India is 0.065 (Fareed et al., 2015), elementary students of Kaliwates subdistrict Jember is 0.13 (Ningrum, 2008), and elementary student of Badung regency Bali is 0.0378 (Karolina et al., 2019). The men allele frequency of color blind was higher than female. Because color blindness is more common in men (Nazeer et al., 2019).

The pedigree analysis results of color blind students family can be shown in Figure 1 and Figure 2.

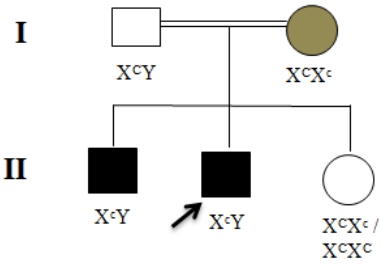

Figure 1. The pedigree analysis of male color blind student family

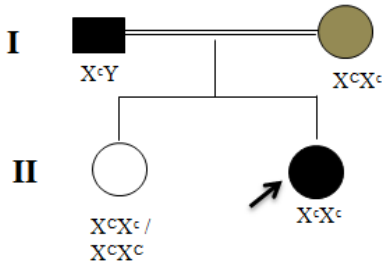

Figure 2. The pedigree analysis of female color blind student family

The pedigree analysis in Figure 1 shows that the gene of color blindness is inherited in a *criss-cross* inheritance pattern. The transmission of a color-blind gene from mother to son, the mother is *carrier*. While the figure 2 shows color blind women have color blind genes from their father who is color blindness and a mother who is a carrier. This characteristic inheritance of color blind which is gene transmission from mother to son or father to daughter (Arsal, 2018). Color blindness female obtain color blind gene from fathers who is color blind and from mothers who is carrier or mothers color blindness (Chaudhari, 2013).

4. CONCLUSSION

The color blindness prevalence of elementary students in Sumbersari subdistrict, Jember is 2.79%, with a male prevalence of 4.86% and a female prevalence of 0.7%. The frequency of the color-blind allele was 0.021 and the normal allele was 0.979. The pedigree analysis of color-blind students family shows the color blindness gene is inherited in a *criss-cross* inheritance. The gene transmission from mother to son or father to daughter.

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