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Incidence and knowledge of genotype and blood grouping among students as a guide to marriage counseling: A case study of FCE Katsina, Nigeria

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[1]Department of Biology, Federal College of Education Katsina. Dutsin-ma Road, Katsina, Nigeria. Tel./Fax.: +234-8113985300, ♥email: rlawalmashi@gmail.com

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Abstract. *Mashi RL, Rafindadi MN, Lawal JY, Inusa YM. 2023. Incidence and knowledge of genotype and blood grouping among students as a guide to marriage counseling: A case study of FCE Katsina, Nigeria. Asian J Trop Biotechnol 20: 17-23.* Marriages have been formed over the years without the genotypes of the intended partners being known. As a result, many families have had children with sickle cell disease. This study examined the distributions of hemoglobin genotypes, ABO, and rhesus blood group patterns among Federal College of Education (FCE) Katsina, Nigeria, students as a reference to marital counseling. This was a cross-sectional study involving 200 students of FCE Katsina. The ABO blood group was determined using the tile method, while the hemoglobin genotype was determined using hemoglobin electrophoresis. Data analysis was done using a simple percentage. The results showed that out of the two hundred students that participated in this study, 146 (73%) of the subjects had HbAA, 51 (25.5%) had HbAS, 3 (1.5%) had HbAC, while there were none with HbSS genotype. The distribution of ABO blood groups of the subjects was; blood group O 114 (57%), blood group B 39 (19.5%), blood group A 39 (19.5%), blood group AB 5 (2.5%), A- 1 (0.5%) and O^- 2(1%). Furthermore, RhD positive was 197(98.5%), while RhD negative was 3 (1.5%). About 119 (59.5%) of the participants have not heard about the blood group, 147 (73.5%) do not know the Hb genotype and 171 (85.5%) are without Rhesus factor knowledge. This study has revealed knowledge and awareness gaps about Hb genotype, Blood group, Rhesus factor, sickle cell disease, and the distribution of ABO blood group amongst Federal College of Education Katsina students. Hence there is a need for massive marriage counseling and health education among students to reduce stillbirth due to Rhesus incompatibility and the burden of SCD, which has become a public health problem in our country.

Keywords: ABO, blood group, genotype, hemoglobin, Katsina, rhesus factor, sickle cell

INTRODUCTION

A blood genotype describes the genetic composition of a person's blood in its totality. No two people are the same. Persons may exhibit some resemblance, appear alike, act, and speak similarly, but no two people are completely identical. There are five different types of blood genotypes. They are as follows: AA, AS, AC, SS, and SC (Bougouma et al. 2012). While the first two pairs (AA and AS) are normal, AC is uncommon, and the last two (SS and SC) are irregular and abnormal, producing sickle cell disease (NIH 2002). Sickle cell disease occurs when an individual's blood cells are distorted and abnormally shaped, potentially limiting blood flow and causing pain and organ damage (Ilesanmi 2010). Before choosing a life mate, blood genotype is an important factor to consider. It is critical because the genotypes of the father and mother eventually cross to define the offspring's genotype (WHO 2006). Therefore, the appropriate knowledge of genotype compatibility can help someone make the optimal quality-of-life decision(s) about marriage and pregnancy. This help to avoid the catastrophic symptoms of sickle cell disease and, as a result, enhances the quality of life. In addition, the AA genotype has the highest compatibility ratio (Omuemu et al. 2013; Zounon et al. 2015).

Individuals with the AA genotype can pick a life partner from nearly all other genotype groups with a very low chance of having sickle-celled kids. According to Williams et al. (2005), while the AA genotype is the most compatible, it is also the most susceptible to malaria. The genotype is an individual's genetic composition, but the phenotype or blood group is the visible trait. The genotype is decided by the kind of hemoglobin found on red blood cells, while the phenotype is established by antigens found on red blood cells, leucocytes, and platelets, as well as antibodies found in plasma. When defined genetically, there are three fundamental sorts of people: those who inherited normal hemoglobin, those who inherited both normal and abnormal hemoglobin, and those who inherited the abnormal hemoglobin solely. As observed in sickle cell syndrome, the inheritance of defective hemoglobin in double dosage exposes one to various hereditary illnesses (Kohne 2011). The phenotypes are hereditary features that aid incompatible blood transfusion, compatible marital union, and treatment of pregnancies caused by incompatible marital unions (Kaine and Udeozo 1981;

Timothy 2000).

One's blood group is determined through genetics, which implies that it is handed on from parents to offspring. It refers to all antibodies (the body's natural defense), antigens (substances that induce the immune system to make antibodies against them), and other chemicals found on the surface of Red Blood Cells (Woldu et al. 2022). The ISBT (International Society of Blood Transfusion) now recognizes approximately 35 blood types; however, only four are widely used. These are A, B, AB, and O blood categories.

In 1941, Landsteiner and Weiner developed the Rhesus (Rh) blood classification (Firkin et al. 1989). The Rh blood type is a multi-antigen system with over 50 antigen expressions expressed by three pairs of tightly connected allelic genes on chromosome 1. However, the most important Rh antigens in medicine are D, C, E, c, and e. (Jahanpour et al. 2017). People with the Rh-D antigen are known as Rh-D positive, whereas those who do not have the antigen are said to be Rh-D negative. If an Rh-D negative individual receives Rh-D positive blood transfusion or an Rh-D negative mother carries an Rh-D positive fetus, the immune system recognizes the antigen as a foreign substance and synthesizes an antibody. That results in a hemolytic transfusion reaction and hemolytic disease in the fetus and newborn (Suresh et al. 2015).

Marriages have been formed over the years without the genotypes of the intended partners being known. As a result, many families have given birth to children. Moreover, the children have died due to neglect or ignorance of understanding their genotype before marriage. This was one of the primary issues for several couples in Nigeria, particularly in the north (Aderotoye-Oni et al. 2018). As a result, this study looked at the distributions of hemoglobin genotypes, ABO, and rhesus blood group patterns among FCE katsina students for marriage counseling.

MATERIALS AND METHODS

Study area

The study was conducted in the Federal College of Education (FCE) located in Katsina local government of Katsina State, Northern Nigeria (Figure 1). Katsina State is located between latitudes 11°08′N and 13°22′N and longitudes 6°52′E and 9°20′E. The state covers an area of 23,938 km^2 and lies in Northern Nigeria within the Sahel Savannah region. The state is bordered by Niger Republic to the North, Jigawa and Kano States to the East, Kaduna State to the South, and Zamfara State to the West. The state has 34 local government areas.

Sample size determination

The sample size is calculated using the Daniel formula (Daniel 1999).

$$n = \frac{Z^2 pq}{d^2}$$

Where: n = sample size, z = z statistics for a level of confidence of 95%, which is conventional, z value is 1.96; p = proportion of people with good knowledge of SCD; q = 1 - p; d = precision; z = 1.96; P = 17% (0.17); d = 0.05

$$n = \frac{(1.96)^2 \times 0.17(1-0.17)}{(0.05)^2}$$

$$\frac{3.84 \times 0.17 \times 0.83}{0.0025}$$

$$\frac{0.5}{0.0025}$$

$$n = 200$$

Two hundred respondents were recruited for the study.

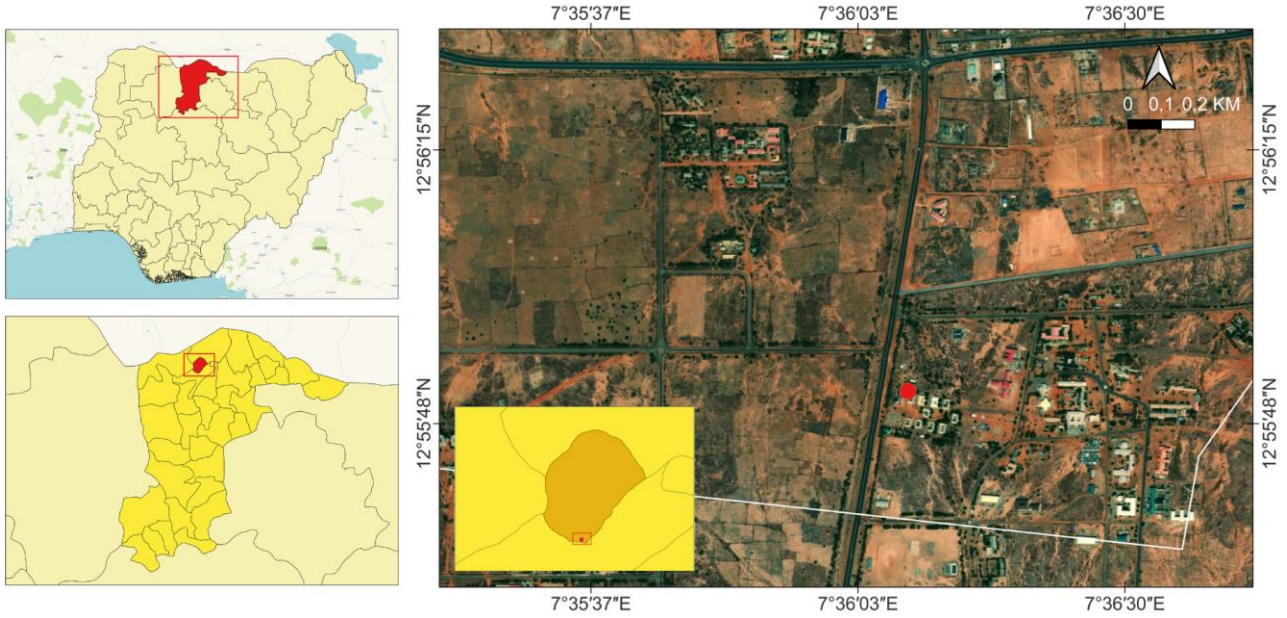

Figure 1. Federal College of Education in Katsina, Katsina State, Nigeria

Study population

A total of 200 study participants aged from 18 years up to 50 years were included. Furthermore, a pre-tested structured questionnaire was employed to collect sociodemographic data, and research participants were requested to provide informed permission. Respondents were randomly selected from third-year students who willingly submitted for the study. All the information was collected anonymously so that no respondent information could be revealed or identified for ethical reasons.

Sample collection

Exactly 2 mL of whole blood was collected aseptically from each subject using the standard vein puncture method. The blood sample was emptied into an EDTA (Ethylene Diamine Tetra-acetic Acid) container. It was properly mixed to avoid clotting and then used to determine hemoglobin, genotype, and blood grouping.

Determination of genotype

Hemoglobin electrophoresis was used to identify the genotype (Ochei and Kolhatkar 2008). Because Hbs are proteins, the migration rate of different hemoglobin (Hb) forms varies. Depending on the charge the Hb carries, they may be arranged to flow to either anode or cathode. The charge carried by hemoglobin is determined by the buffer employed (Hb). For example, when alkaline cellulose acetate is utilized in an alkaline buffer with a pH of 8.4, the Hb prefers to migrate to the anode, where there is a negative charge (Ochei and Kolhatkar 2008).

Each patient's venous blood hemolysate was deposited on the cellulose acetate membrane before being gently injected into the electrophoresis tank containing Tris - EDTA - Borate buffer at pH 8.6. The electrophoresis was then allowed to continue for 15 - 20 minutes at a voltage of 160 V. The findings were immediately read. As controls, haemolysates from known hemoglobin (AA, AS, AC) blood samples were used.

Determination of blood group

The tile and tube procedures were employed to determine the blood group (Karle Lanstiner 1901).

Tile method: On a clean tile, one drop of whole blood was deposited, and an equivalent amount of commercially produced standard antiserum (anti-A, anti-B, anti-D) was mixed in. After 2 minutes of incubation at room temperature, the observations were microscopically recorded using the naked eye.

Tube Method: The tube method was carried out for tile using cells, and the result was recorded for the tile grouping method. ABO and Rh-D blood group information was gathered utilizing a data-gathering methodology. To maintain the quality of the results, known positive and negative A-cell, B-cell, and Rh-D cells were employed.

Ethical consideration

Permission was obtained from the ethics committees of the Federal College of Education, Katsina State, Nigeria. Informed consent was obtained from the participants before sample collection. Refer to the appendix for the details of the questionnaire and consent form administered to the respondents in hard copy.

Data analysis

The data obtained were analyzed using percentages (%) and presented in tables and bar charts.

RESULTS AND DISCUSSION

Results showed that out of 200 participants, 130 (65%) were male, while 70 (35%) were female. The majority of the participants, 117 (58.5%), fall within the age bracket of 23-27 years, 68 (34%) aged 18-22 years, 10 (5%) aged 28-32 years, and 5 (2.5%) aged 33 years and above and larger proportion of the participants were single, 192 (96%), and only 8 (4%) were married as shown in Figure 2.

Table 1 shows the distribution of O^+, A^+, B^+, AB^+, A^- , and O^- blood groups among the participants as 114 (57%), 39 (19.5%), 39 (19.5), 5 (2.5%), 1 (0.5%) and 2 (1%) respectively, with Rhesus D positive (98.5%) and Rhesus' D' negative (1.5%). The distribution of the Hb genotype of HbAA 146 (73%), HbAS 51 (25.5%), and HbAC 2 (1%), respectively.

Table 2 shows the distribution of Hb Genotype and Blood group by gender of the participants as Hb genotype of HbAA male 93 (46.5) and Female 53 (26.5), HbAS Male 36 (18%) and Female 15 (7.5%), HbAC Male 1 (0.5%) and Female 1(0.5%) respectively and O^+, A^+, B^+, AB^+, A^- and O^- blood groups among the participants as male 98 (39%) and Female 36 (18%), Male 19 (9.5%) and Female 20 (10%), male 25 (12.5%) and female 4 (7%), 5 (2.5%), 1 (0.5%) and 2 (1%) all males respectively.

The participant's knowledge of the Hb genotype, blood group, Rhesus factor, and SCD, as shown in Table 3, revealed that the majority of the participants have not heard about the Hb genotype (25%), blood group (40.5%), Rhesus factor (14.5%) and sickle cell disease (26.5) respectively. Furthermore, the majority, 163 (81.5%), were Hausa, 12 (6%) were Fulani, and 25 (12.5%) others, as shown in Figure 3.

Table 1. Distribution of Hb genotype, blood group, and Rhesus factor among the participants

Variables	Categories	Frequency	Percentages (%)
Hb genotype	AA	146	73
	AS	51	25.5
	AC	3	1.5
	SS	0	0
ABO	A^+	39	19.5
	B^+	39	19.5
	AB^+	5	2.5
	O^+	114	57
	A^-	1	0.5
	O^-	2	1
Rhesus	Positive	197	98.5
	Negative	3	1.5

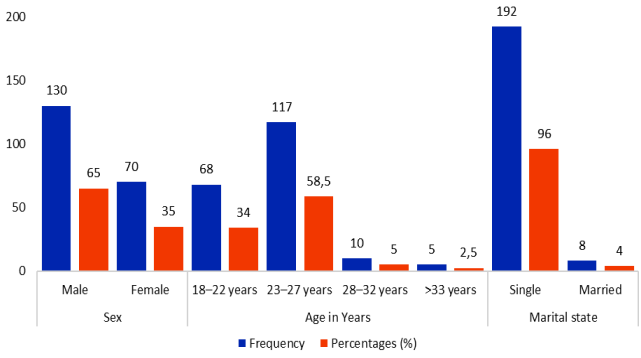

Figure 2. Distribution of gender, marital status, and age among the participants

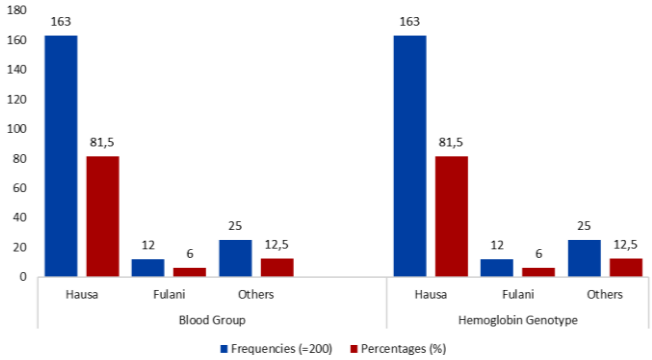

Figure 3. Distribution of blood group and hemoglobin genotype by ethnic group among the participants

Table 2. Distribution of Hb genotype, blood group, and Rhesus factor by gender of the participants

Variables		Males		Females		Total
		Freq.	Percent.	Freq.	Percent.	%
ABO	A^+	19	9.5	20	10	19.5
	B^+	25	12.5	14	7	19.5
	AB^+	5	2.5	0	0	2.5
	O^+	78	39	36	18	57
	A^-	1	0.5	0	0	0.5
	O^-	2	1	0	0	1
	Total	130	65	70	35	100
Hb genotype	AA	93	46.5	53	26.5	73
	AS	36	18	15	7.5	25.5
	AC	1	0.5	2	1	1.5
	SS	0	0	0	0	0
	Total	130	65	70	35	100

Table 3. Participants' knowledge of Hb genotype, blood group, Rhesus factor, and SCD

Variables	Labels	Frequencies (n=200)	Percentage (%)
Hemoglobin genotype	Yes	50	25
	No	150	75
Blood group	Yes	81	40.5
	No	119	59.5
Sickle cell disease	Yes	53	26.5
	No	147	73.5
Rhesus factor	Yes	29	14.5
	No	171	85.5

Discussion

The findings of this study revealed that out of the 200 participants, 130 (65%) were male, while 70 (35%) were female. This might not necessarily mean more male students are in the college where this study was conducted. Still, the male students were more interested in the study than the female since the individuals in this study were allowed to participate willingly. This low interest in the participation of females may be ascribed to the aspects of beliefs, intimidation of girls by boys, gender stereotyping in science, and scarcity of female models in science and technology. The majority of the participants, 117 (58.5%), fall within the age bracket of 22-27 years, 68 (34%) aged 18-22 years, 10 (5%) aged 28-32 years, and 5 (2.5%) aged 33 years and above, this is because most of the third year students were within this age brackets in the studied area. The majority, 163 (81.5%), were Hausa, 12 (6%) were Fulani, and 25 (12.5%) others, because the Hausa Tribe dominates the study area. A larger proportion of the participants were single, 192 (96%), and only 8 (4%) were married because most undergraduate students were single in the study area.

According to Ethiopian research on ABO distribution, the "O" blood type was the most prevalent, followed by the "A" and "B" blood groups (Atire 2015; Tesfaye et al. 2015; Tiruneh et al. 2020; Woldu et al. 2022). The proportion of people with the blood group "O" ranged from 21.67% to 47.04% (Abegaz 2021; Woldu et al. 2022). The "AB" blood group, on the other hand, was the least common blood group type, with a prevalence ranging from 2.87% to 24.7% (Abegaz 2021). The most frequent blood group was Rh-D positive, accounting for 92.77% to 60.13% of the population (Abegaz 2021). In the present study, the distribution of O^+, A^+, B^+, AB^+, A^- , and O^- blood groups among the students of Federal College of Education, Katsina, was 114 (57%) male, 98(39%), and Female 36 (18%), 39 (19.5%) Male 19 (9.5%) and Female 20 (10%), 39 (19.5) male 25 (12.5%) and female 14 (7%), 5 (2.5%), 1 (0.5%) and 2 (1%) all males respectively. The research indicated that the "O" blood type was the majority blood group, followed by A and B, AB, O^- , and the least prevalent blood group was A^-. This study is comparable to a study completed in Nigeria (Odokuma et al. 2007; Enosolease and Bazauye 2008; Erhabor et al. 2013), in Ethiopia (Zerihun and Bekele 2016; Golassa et al. 2017; Legese et al. 2021), in Bangladesh (Talukder and Das 2007) and India (Sharma et al. 2013). According to these studies, the "O" blood group was the most prevalent, while the "AB" blood group was the least common.

The Rh D positive blood group was most common in this study accounting for 98.5%; this is similar to the work of Erhaboe et al. (2013) and Legese et al. (2021). Equally, the frequency of Rhesus-positive antigen in this study, 98.5%, is also in the same range as 96.7% recorded for the Ibos by Ukaejiofor et al. (1996) and similar to 97.7% found

in Port Harcourt by Jeremiah (2005). It is a striking result in this study that 1.5% of Rhesus negatives were all males. This percentage of Rhesus negative observed in our study (1.5%) is significantly lower than the prevalence rate of >14% Rh (D) negative phenotype observed in studies among Caucasians (Cerny et al. 1992). Several obstetric advantages are associated with the low prevalence of D-negative among the studied population in Katsina. Therefore, the risk of Rh (D) alloimmunization will be of a much smaller magnitude than it is in most Western countries, where a significant proportion of the population lacks the major Rh (D) antigen (Erhabor et al. 2013).

However, this study is in contrast with a study conducted in Ethiopia which showed blood group A in the dominant (Abegaz 2021) and in India (Barot et al. 2020) and Pakistan (Pramanik and Pramanik 2000; Khattak et al. 2008) which showed blood group B is dominant than O group. The disparity between our findings and those of other research might be due to variations in sample size, sampling procedure, and genetic diversity between ethnic groups within other countries' populations.

The frequencies of the HbAA 146 (73%) male 93 (46.5) and Female 53 (26.5), HbAS 51(25.5%) Male 36 (18%) and Female 15 (7.5%), HbAC 2 (1%) Male 1 (0.5%) and Female 1(0.5%), respectively. Our finding is similar to the work of Kaine and Udeozo (1981), who got HbAS of 25% and HbAC of 0.1% in Igbo land, southeastern Nigeria. The result also agrees with Afolayan and Jolayemi's (2011) work, which found 25% of sickle cell trait prevalence in Nigeria. Although the prevalence of HbAA was the highest, the presence of the HbAS and HbAC among the studied population may suggest the possibility of many other residents in the capital city of Katsina State carrying abnormal forms of hemoglobin genotype. Therefore, that could call for more efforts in genetic counseling in this area. The prevalence of HbAS and HbAC above other abnormal hemoglobin genotypes HbSS, HbSC, and HbCC in this study could be justified by the presence of one normal allele coding for a normal polypeptide globin chain which confers on the hemoglobin better affinity for oxygen. Hence, individual carriers of these abnormal hemoglobin genotypes still live a normal life, unlike in the case of HbSS and HbCC (Akinboro et al. 2016).

This study shows poor knowledge of Hb genotype (25%), blood group (40.5%), Rhesus factor (14.5%), and sickle cell disease (26.5%), respectively, by the participants. This is similar to research by Adewuyi (2000) in Ilorin, Nigeria, who reported poor knowledge among fresh graduate students. Similarly, Bazuaye and Olayemi (2009) also reported in their study that more than half of the participants in Benin City did not know their genotype and only a few respondents had good knowledge about sickle cell disease. The participants' lack of understanding of the sickle cell genotype and the Rhesus antigen was unexpected, given their level of education. This finding demonstrates how little awareness numerous people in Katsina may have regarding sickle cell illness and neonatal hemolytic anemia. Nevertheless, due to cultural views in the investigated region, the conclusion might be ascribed to a lack of awareness or an unwillingness to embrace health-enlightening programs.

In conclusion, this study has revealed knowledge and awareness gaps about the Hb genotype, Blood group, Rhesus factor, and sickle cell disease, and the distribution of the ABO blood group was O>A>B>AB, while the genotype was HbAA>HbAS>HbAC, respectively amongst the students of Federal College of Education Katsina. Hence there is a need for massive marriage counseling and health education among students to reduce stillbirth due to Rhesus incompatibility and the burden of SCD, which has become a public health problem in our country.

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Appendix

RESEARCH QUESTIONNAIRE

Sociodemographic characteristics
Age/date of birth ……..….
Gender: Male [ ], Female [ ]
Marriage [ ], Single [ ]
Ethnic group: Hausa [ ], Fulani [ ], Yoruba [ ], Igbo [ ], others …….…..

Knowledge of blood group and genotype
1. Did you know anything about Hb genotype? Yes [ ], No [ ]
2. Did you know anything about Blood group? Yes [ ], No [ ]
3, Did you know anything about Sickle cell anemia? Yes [ ], No [ ]
Did you know anything about Rhesus factor? Yes [ ], No [ ]
Did you know anything about still birth? Yes [ ], No [ ]

Consent
Name ……
Age ……
Sex ……
Address……
Phone number……
E mail……
Occupation……

I, the undersigned hereby willingly wish to participate in the above study, and consent to collect my blood sample to assay for Blood group and genotype, having understood the questionnaire and the professional counseling by the researcher. I understand that I will be informed of the outcome of the findings on my sample.

Signature……
Date……
Time……