



Frequency Distribution of Hemoglobin Variants among Teenagers

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Authors' contributions

This work was carried out in collaboration between all authors. Authors AAA and OAO designed the study, wrote the protocol, analyzed the samples and wrote the first draft of the manuscript. Authors AOL and DDO managed the literature searches, analyzed the data and wrote the final draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The intent of this study is to report the distribution of hemoglobin variants among teenagers in South -West Nigeria.

Study Design: Cross sectional study.

Place/Duration: Babcock University, Ilisan-Remo, Ogun State, South-West Nigeria between September 2013 and March 2015.

Methods: Hemoglobin (Hb) variants were determined in two thousand, four hundred and six teenagers using the alkaline electrophoresis method.

Results: The distribution of Hemoglobin electrophoresis is as follows; HbAA 1821 (75.7%), HbAS 498 (20.7%), HbAC 47 (2.0%), HbCC 01 (0.0%), HbSC 12 (0.5%), HbSS 27 (1.1%).

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Conclusion: The incidence of hemoglobinopathies is reduced among the teenagers in South-West Nigeria.

Keywords: Incidence; hemoglobinopathies; sickle cell trait; Nigeria; sickle cell disease; teenagers.

1. INTRODUCTION

Hemoglobinopathies are the most common gene disorder worldwide with about seven percent of the world population being a carrier of significant hemoglobinopathy mutation [1]. The disease is highly endemic in sub-Sahara and equatorial Africa, with lesser, though significant prevalence in the Middle East, Indian, and the Mediterranean region. As a result of explosive population migration to the industrialized western countries, hemoglobinopathies have become endemic throughout the world population.

HbS is an underlying abnormality in which a single nucleotide substitution (GTG for GAG) in the gene for beta globin on short arm of chromosome 11, resulting in the replacement of a glutamic acid residue with valine on the surface of the protein. Normally, adult HbA has two chains of alpha globin and two beta globin chains which form a tetramer, stabilized by specific intramolecular points of contact, but without interactions between individual tetramers within the red blood cells. In HbS, deoxygenation exposes valine residue on the surface of the molecule, which forms hydrophobic interactions with adjacent chains, the resulting polymers align into bundles, causing distortion of the RBC into a crescent or sickle shape, consequently, reduces flexibility and increase deformability, which hinders passage of the cell through narrow blood vessels.

The clinical hallmark of this disease is vaso-occlusive disease and hemolytic crisis. Sick cell, along with non-sickled erythrocytes, leucocytes, and platelets form heterocellular aggregates. The aggregates adhere to vascular endothelium causing obstruction of the lumen of small blood vessels. This microcirculatory obstruction leads to tissue ischemia and infarction which can cause several organ damage, long-term disabilities, and short life span. Vaso-occlusion results in painful episodes known as sickle cell crisis. Hemolytic crisis is as a result of the premature destruction of red blood cell by the reticuloendothelial system, partly due to their rigidity which makes susceptible to being filtered away in the spleen and partly due to changes in the structure of the lipid bilayer, which enhance phagocytosis.

Sickle cell disorders include the homozygous state for Hemoglobin S, or sickle cell anaemia (SS), the heterozygous state for Hemoglobin S or the sickle cell trait (AS), and the compound heterozygote state of Hemoglobin S together with other haemoglobin variants such as C, D, E, O- Arab or other structural variants. As at 1992, there were 78 million carriers of sickle cell trait worldwide with most of them living in sub-Sahara Africa [2]. Studies have also shown that about 300,000 infants are born annually with major hemoglobin disorder out of which sickle cell anaemia has the highest incidence, majority of these cases occur in West Africa with Nigeria presenting the highest number of case [3]. In Nigeria, there are six principal hemoglobin genotypes these are; HbAA, HbSS, HbAS, HbSC, HbAC, HbCC. While the hemoglobin C variance is reported to be largely confined to the Yorubas living in the south-western part of the country and it has a prevalence of 6 percent [4], the distribution of other variants is; 55–75% HbAA, 20 -30% HbAS, and 3 -4% HbSS [5,6,7].

Over the years, there are lots of efforts from international, national, and local agencies towards addressing hemoglobinopathies as a public health issue in the south-western Nigeria with the aim of curbing and ultimately eradicating the disease. Such efforts include; awareness campaigns in electronic and print media, pre and postnatal diagnosis, pre-marital counselling, and surveillance. Furthermore, there is a continuous significant improvement in the literacy level of the people in this region, also their socioeconomic status, and hygiene culture have been upgraded.

With the level of public awareness of the sickle cell disease, and current living condition in South-West, Nigeria, we hypothesize that the younger generation should have a reduced prevalence of hemoglobinopathies. Although some studies have reported the prevalence of hemoglobinopathies [5,6,7,8] in Nigeria, there is none whose subject is strictly teenagers, therefore, this study was designed to report the incidence of hemoglobinopathies among the native Nigeria teenagers in south West, Nigeria. Our report will be beneficial to the nation, firstly, because there is a need to have a scientifically based evidence to evaluate the progress made so far in curbing this inherited disease in south-

west Nigeria. This might be useful to the policy makers to decide either to stick to the current policies or chart a new course for curbing and eradicating the disease, and secondly, it might give us the opportunity to predict what the situation may look like in the next generation as these teenagers, most probably, constitute the gene pool from which alleles of the offspring of the future generation will be made.

1.1 Study Population

Two thousand four hundred and six students of Babcock University, Ilisan-Remo were recruited for this study; they have an age range of 15 – 19 years with a mean of 18.1(±1.7) years. The students comprise of 1083 males with mean age of 18.3(±1.3) years, and 1323 females with mean age of 18.0(±1.4) years. The students are ensured to be native Nigerian students only; consent was sorted and obtained from the ethical committee of the university.

1.2 Study Area

This cross sectional study took place between September 2013 and March 2015 at Babcock University, Ilisan-Remo, Ogun State, South West, Nigeria. The university is a Christian co-educational school named after an American missionary, David C. Babcock, who pioneered the work of the Seventh-day Adventist Church in Nigeria in the year 1914. The school is one of the pioneers of private tertiary education in Nigeria. It was inaugurated on April 20, 1999, owned and operated by Seventh-day Adventist Church of Nigeria and located equidistant between Lagos and Ibadan, with an enrollment of over 10,000 students. The University has 9 schools and 1 college providing tertiary education for Nigerians, and international students.

2. METHODS

2 mls of blood was collected aseptically from the dorsal vein of the students and put into EDTA bottle and mixed gently to prevent clotting. A portion of the blood was put in a clean khan tube and washed 3 times with normal saline (0.85% sodium chloride). The washing was done by adding normal saline to the blood and spinning the mixture for 3 minutes at 1500rpm in a bench centrifuge at room temperature. Six drops of Helena hemolysate were added to the sediment and allow standing 3 minutes so as to lyse the blood sample.

The lysed samples were applied on Helena cellulose acetate paper using the Helena plate

and applicator, and the paper was placed in the Helena electrophoresis tank containing a commercially prepared Tris-EDTA-Borate buffer, the pH of the buffer is 8.6. The electrophoretic separation was allowed at room temperature for 15 - 20 minutes at 220V as the electromotive force. A commercially prepared Helena known hemoglobins were run as controls along with the test, and the results were read immediately after the end of the test time. The buffer powder was manufactured by Helena and reconstituted in distilled water as instructed by the manufacturer. The percentage distribution of hemoglobin variant was calculated and reported in simple percentage.

3. RESULTS

Two thousand four hundred and six students of Babcock University, Ilisan-Remo, Ogun state, South West, Nigeria were enrolled for this study, Table 1 shows distribution of hemoglobin genotype among the Nigerian teenagers as thus; hemoglobin AA 1821 (75.7%), AS 498 (20.7%), AC 47(2.0%), SC 12(0.5%), CC 01(0.0%), SS 27(1.1%). The distribution of hemoglobin genotype among genders in Nigerian teenagers is represented in Table 2, here, we observed that the males exhibit high prevalence of hemoglobinopathy in homozygote form, while the heterozygote form of the disease is higher in the females.

Table 1. Distribution of hemoglobin genotype among native Nigeria teenagers (n = 2406)

Hb genotype	Number	Percentage
AA	1821	75.7
AS	498	20.7
AC	47	2.0
SC	12	0.5
CC	01	0.0
SS	27	1.1
Total	2406	100

4. DISCUSSION

Hemoglobinopathies are among the most commonly inherited genetic disorder worldwide and it is inherited as autosomal recessive disorders from healthy- carrier/disease parents. The percentage distribution of HbAA in our studies is 75.7%. This shows slight but insignificant increase compare with the value previously reported for Africa which is 50-75% [9]. This may indicates that normal hemoglobin gene pool is maintain in the studied group and implies sustainability of this hemoglobin in the region.

Table 2. Distribution of hemoglobin genotype among genders in native Nigeria teenagers (n=2406)

Gender	HbAA N (%)	HbAS N (%)	HbAC N (%)	HbSC N (%)	HbCC N (%)	HbSS N (%)
Male	806 (74.4)	233 (21.5)	22 (2.0)	04 (0.4)	01 (0.1)	17 (1.6)
Female	1015 (76.7)	265 (20.0)	25 (1.9)	08 (0.6)	00 (-)	10 (0.8)
Probability (Chi square)	0.99	0.85	0.67	0.75	0.68	0.82
Total	1821 (75.7)	489 (20.7)	47 (2.0)	12 (0.5)	01 (0.0)	27 (1.1)

A percentage distribution of 20.7% was reported for HbAS in this study. This is in agreement with 20-30% recorded for Nigeria and within the value of 20-40% recorded for Africa, [5,6,7] this may be due to the fact that nature plays a role in the choice of gene so as to protect the inhabitant of this region against malaria parasite because south-west Nigeria is known to be endemic for malaria and sickle cell trait has been proven to confer some protections against malaria. The percentage distribution of AS in our study is at the lowest level of the reference value for Nigeria and Africa as a whole, it is also lower than previously published data for south-western Nigeria [10,11,12], except that which was reported as 18.1% in 2013 by Oyeyemi et al. [8]. This disagreement may be as a result of the choice of our subject and the sample size.

The prevalence of HbSS is 1.1% in this study, this value is within the published value for Africa which is 1-10%, [13] but lower than that previously reported for the southwestern region of Nigeria, [11,12] although, Akighbe et al. [10] reported a lower value of 0.54% in 2009, the reason for this may be the difference in the average age of the subjects as well as the volume of the sample. The reason for the difference in percentage distribution of HbSS in this study and that previously reported for the region may largely be that many children with SS disease died during the first years of life. It may also be that the sickling gene pool is gradually shrinking which may be as a result of social initiatives, and medical advances – these claims need further studies to ascertain though.

HbAC, HbCC, and HbSC have 2.0%, 0.0%, and 0.5% percentage distribution respectively in this study. These values are reduced compared to those reported previously [10]. This again may indicate the shrinking of the abnormal hemoglobin gene in the younger generation of the inhabitants of this region. There is no gender bias in the mode of inheritance as shown in Table 2 (P<0.05), this is in agreement with

previous work [14]. Table 3 shows that X2 calculated is greater than X2 table in the three major hemoglobin genotype, therefore the studied population is not in Hardy- Weinberg equilibrium.

Table 3. Observed number against Hardy-Weinberg expectations in teenagers with major hemoglobin genotypes

	HbAA	HbAS	HbSS
Observed	1821	498	27
Expected	1829.9	492.7	23.5

$N= 2346; X^2 = 0.622; P = 0.555$

5. CONCLUSION

In conclusion, this study is limited methodological because some abnormal hemoglobins have similar electrophoretic mobilities and must be differentiated by other techniques, the percentage distribution of HbAA is maintained and the prevalence of hemoglobinopathy in the studied group is at the lowest, also, the studied population is not in Hardy- Weinberg equilibrium, all of these are indications that this disease can be curbed and ultimately eradicated by maintaining / improving on the current policies.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Okpala I, Thomas V, Westerdale N, Dick M, Bewley S, Davies M and Abbs I. The comprehensive care of sickle cell disease. Eur J Haematol. 2002;68:157-62.
- Modell B, Darlison M. Global epidemiology of haemoglobin disorders and derived service indicators. Bull World Health Organ. 2008;86:480-7.

3. Akinyanju OO, Disu RF, Adewole TA, Otaigbe AI, et al. Initiation of prenatal diagnosis of sickle cell disorders in Africa. *Prenat Diagn.* 2000;19(4):299-304.
4. Akinyanju OO. A profile of sickle cell diseases in Nigeria. *Ann N Y Acad Sci.* 1989;565:126-36.
5. Erabor O, Adias TC, Jeremiah ZA, Hart ML. Abnormal haemoglobin variants, ABO, and Rhesus blood group distribution among students in Niger Delta of Nigeria. *Pathol Lab Med Int.* 2010;2:41-46.
6. Jeremiah ZA. Abnormal haemoglobin variants, ABO and Rh blood groups among student of Africa descent in Port Harcourt. *Nigeria. Afr Health Sci.* 2006;6:177-81.
7. Bakare AA, Azeez MA, Agbolade JO. Gene frequency of ABO and Rhesus blood groups and haemoglobin variants in Ogbomosho, South-West, Nigeria. *Global J Med Sci.* 2004;3:17-22.
8. Oyeyemi IT, Salawu OT. Frequency distribution of hemoglobin variants and rhesus blood groups among pregnant women. *American Medical Journal.* 2013; 4(1):78-81.
9. Yakubu A, Zama I, et al. Haemoglobin electrophoretic pattern among resident in Sokoto, Nigeria. *J Med Disord.* 2012;1:2.
10. Akhigbe RE, Ige SF, Afolabi AO, Azeez OM, Adegunlola GJ, Bamidele JO. Prevalence of haemoglobin variants, ABO and Rhesus blood groups in Ladoke Akintola University of Technology, Ogbomosho, Nigeria. *Trends Med Res.* 2009;4:24–29.
11. Idowu AT, Olufemi AO, Ade OD. Frequency of sickle cell genotype among the Yorubas in Lagos: Implication of the level of awareness and genetic counselling for sickle cell disease in Nigeria. *J Community Genet.* 2011;2:13-18.
12. Nubila T, Ukaejiofo EO, Nubila NI, Azeez R. Frequency distribution of hemoglobin variants among Yorubas in Ibadan, South western Nigeria: A pilot study. *Niger J Exp Cli Biosci.* 2013;1:39-42.
13. Esan AJ, Omisakin CT, Okhuakhua D. Frequency distribution of hemoglobin variant, ABO, and rhesus blood groups among children in Ido / Osi Local government, Ekiti State Nigeria. *Journal of Medical Laboratory Science.* 2012;21:2.
14. Pennap GR, Envoh E, Igbawua I. Frequency distribution of heamoglobin variants, ABO and Rhesus blood groups among students of African descent. *Br Microbiol Res J.* 2011;1:33-40.

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