Echelon of Haemoglobin Genotype Variants in Anambra State Southeast Nigeria from 2005 to 2019

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Abstract

Haemoglobin genotypes are very important in the sub-Saharan African, it aids in assessing the health of an individual. About 85 million people are carriers of different Hb genotype variants in Sub-Saharan Africa. The aim of this study is to establish the echelon of haemoglobin genotype variants in Anambra state Southeast Nigeria from 2005 to 2019. A total number of 50,169 retrospective records of haemoglobin genotype results were analyzed using the Statistical Package for Social Sciences (SPSS) computer software. The study showed that 74.65% were Hb genotype AA, 23.16% were Hb genotype AS, 0.26% were Hb genotype AC, 1.84% were Hb genotype SS and 0.09% were Hb genotype SC. The female subjects had higher frequency distributions in Hb genotype AA, AS, and SC, than the male. The Hb genotype AA ranked the highest Hb genotype variants, followed by Hb genotype AS, SS, AC and lastly SC in Anambra state, Southeast Nigeria.

Keywords: Echelon, Haemoglobin genotype, Anambra state

Introduction

Hemoglobin is the iron-containing oxygen-transport metalloprotein in the red blood cells of all vertebrates,[1] The intracellular protein in the erythrocytes consist of four polypeptide globin chains, each of which is folded around a heme molecule. It is responsible for the transport of oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. [2] The globin chains are encoded by their respective genes located on chromosome 11 and chromosome 16 and are both known to have several alleles [2].

There are different types of Hemoglobin (Hb); among them are Hemoglobin A (HbA), Hemoglobin S (HbS) and Hemoglobin C (HbC). An Individual has a pair of this hemoglobin in their blood, each inherited from both parents in the forms of HbAA, HbAS, HbAC, HbSC, HbSS or HbCC [3].

Haemoglobin A occurs when the amino acid glutamate is at position 6 of both globin chains of the haemoglobin and is the only normal genotype in the red blood cell. This normal hemoglobin HbA is the most frequently recorded of these as genotype AA [4, 5] when an individual inherit each of these Hb A from each of the parent. Variants of genotype AA are of importance because of their various associated pathological problems [6]. Defects in Hb genes produce abnormal Hb which leads to hemoglobinopathies [6]. Hemoglobinopathy is the most common human genetic problem affecting 7% of the world's population [7]. It is a type of genetic defect that results in an abnormal structure of the globin chains in the hemoglobin molecule. [3] The World Health Organization is concerned about the alarming rate at which it spreads in more than 70% of the countries of the world [7]. The most commonly encountered abnormal hemoglobin genotypes among Nigerians include AS, AC, CC, SC, and SS [8]. Hemoglobin S occurs when the amino acid valine occupies the globin chain at position 6 of the Haemoglobin. [3] Hemoglobin C occurs when the amino acid lysine occupy the globin chain at position 6 of the Hemoglobin [3].

Hemoglobin SC occurs when the amino acid valine occupies one of the globin chains and lysine occupies the second globin chain at position 6 of the Haemoglobin. [3] Hemoglobin SS occurs when the amino acid valine is at position 6 of both globin chains of the Haemoglobin.[3] The number of Hb variants has been increasing since the discovery of HbS in 1949 [9], over 600 variants of HbA are known today.

Hemoglobin genotyping is the process of determining the red blood cell genetic make-up of an individual by examining the individual's DNA sequence using biological assays and comparing it to a reference sequence. [10] The frequency or distribution of genotype variants differs in places; some variants are most common in a certain area while others are

rare. In Nigeria, several reports [11-15] are available on the distribution of hemoglobin genotypes among different populations across the geopolitical zones in the country, but there is no report on various forms of Hb genotypes and pattern of their distribution among the human population in Anambra state, Southeast Nigeria. Hence this study was aimed to see the echelon of haemoglobin genotype variants among the subjects carrying out test on Haemoglobin genotype in Nnamdi Azikiwe University Teaching Hospital, Nnewi Anambra State Southeast Nigeria for the past 15 years from 2005 –2019.

Material and Methods

Retrospective records of hemoglobin genotype data generated from the results of blood tests that we carried out from 2005 to 2019 in the department of Haematology / Blood serology of Nnamdi Azikiwe University Teaching Hospital were used. The acceptable standard procedure for hemoglobin genotypes investigations such as Sickling test, Solubility test, Hemoglobin electrophoresis using cellulose acetate paper were used and the various forms of hemoglobin genotypes observed in the patients' blood samples were recorded. A total number of 50,169 haemoglobin genotype results were analyzed using the Statistical Package for Social Sciences (SPSS) computer software. The chi-square test was for comparison and $P < 0.05$ was regarded as being statistically significant. The Hardy-Weinberg law [16], was used to calculate the predicted distribution of the hemoglobin genotype in the population.

Results

The percentage of the various haemoglobin genotypes obtained in the study are shown on Table1. Out of the total number of 50,169 subjects screened, 74.65% were HbAA, 23.16% were Hb AS, 0.26% were Hb AC, 1.84% were Hb SS and 0.09% were Hb SC. Among the total population studied, the hemoglobin genotype AA (HbAA) recorded the highest frequency distribution (74.65%). While HbSC recorded the least percentage distribution (0.09%). The female subjects had higher frequency distributions in AA, AS, and SC, while the male demonstrated higher frequencies in AC and SS only. The average percentage distribution of hemoglobin genotype variant was calculated and reported in simple percentage.

YEARS	AA		AS		AC		SS		SC	
	Total	%	Total	%	Total	%	Total	%	Total	%
2005	1061	70.35	418	27.71	4	0.27	24	1.60	1	0.06
2006	984	69.93	399	28.36	3	0.22	21	1.49	0	0.00
2007	1612	74.91	516	23.98	3	0.14	19	0.88	2	0.09
2008	1249	73.81	413	24.41	4	0.24	25	1.48	1	0.06
2009	998	72.42	361	26.20	2	0.15	17	1.23	0	0.00
2010	1447	69.63	598	28.78	6	0.29	26	1.25	1	0.05
2011	1991	76.34	573	21.97	7	0.27	36	1.38	1	0.04
2012	3108	76.05	898	21.97	7	0.17	70	1.71	4	0.10
2013	2428	73.72	744	22.62	8	0.24	105	3.19	4	0.12
2014	2103	74.44	644	22.80	10	0.35	64	22.65	4	0.14
2015	835	73.18	274	24.01	7	0.62	25	2.19	0	0.00
2016	987	72.73	342	25.20	7	0.37	18	1.33	3	0.22
2017	705	73.67	228	23.82	5	0.52	18	1.04	1	0.10
2018	1784	74.99	551	22.85	7	0.29	67	2.78	2	0.08
2019	2822	82.65	523	15.32	5	0.15	60	1.76	4	0.12
TOTAL	24,114	74.65	7,482	23.16	85	0.26	595	1.84	28	0.09

Table 1: Percentage of different hemoglobin genotypes recorded

Year	Gender	AA	AS	AC	SS	SC
2005	Male	457	200	3	14	0
	Female	604	218	1	10	0
2006	Male	300	199	3	10	0
	Female	684	200	0	5	0
2007	Male	800	216	1	7	1
	Female	812	300	2	3	0
2008	Male	500	203	2	8	0
	Female	749	210	2	6	0

2009	Male	500	163	1	9	0
	Female	498	198	1	5	0
2010	Male	657	280	4	16	0
	Female	790	318	2	10	1
2011	Male	779	253	6	18	1
	Female	1,212	320	1	18	0
2012	Male	1,221	360	2	38	0
	Female	1,887	530	5	32	4
2013	Male	962	298	3	60	0
	Female	1,428	446	5	45	4
2014	Male	939	282	6	35	1
	Female	1,164	364	4	29	3
2015	Male	363	124	5	14	0
	Female	472	150	1	11	0
2016	Male	414	152	3	10	3
	Female	573	190	4	8	0
2017	Male	323	93	3	9	0
	Female	382	135	2	9	1
2018	Male	812	258	1	28	2
	Female	972	293	6	39	0
2019	Male	880	229	1	39	1
	Female	1,942	294	4	21	2

Table 2: Frequency of hemoglobin variants among gender

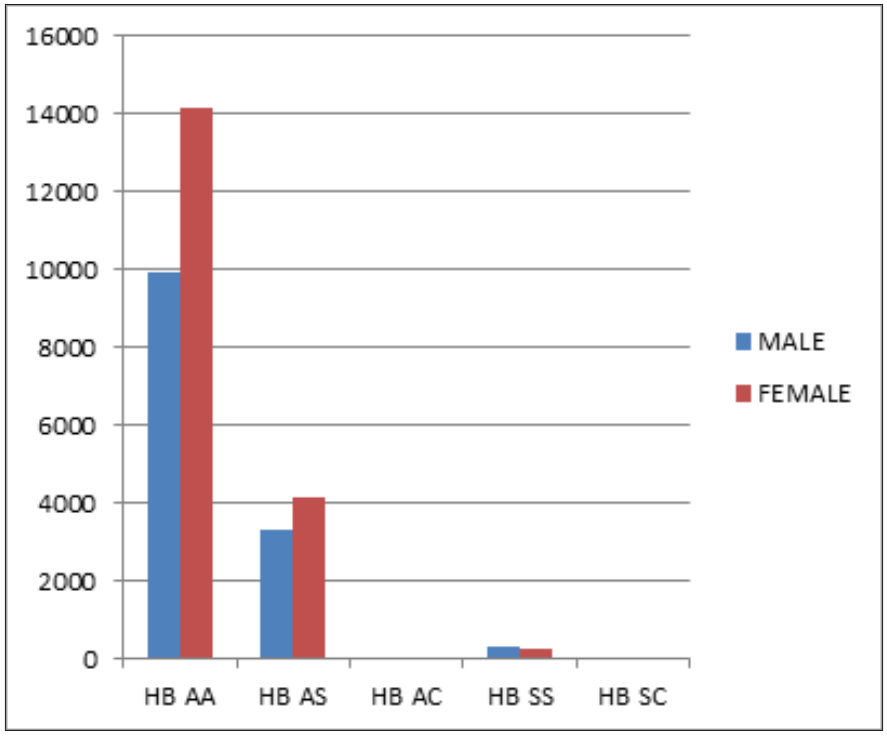

Figure 1: HB GENOTYPE AMONG THE MALE AND FEMALE

Discussion

Haemoglobin genotype is must for everyone and inherited from each of the parents to form a pair, Hemoglobin carries oxygen within the erythrocytes and distributes to different parts of the body. Normal hemoglobin genotype (HbAA) has greater affinity for oxygen and delivers same to the cells for energy (ATP) production unlike the abnormal haemoglobin. Haemoglobin genotype determination is necessary for everyone, schools need haemoglobin genotype from students before admission, Government and non-government establishments require haemoglobin genotype before employment is given, haemoglobin genotype is also done before marriage to help prevent spread of abnormal hemoglobin genotypes like SS, SC and CC. Patients with abnormal hemoglobin genotype were also managed when detected. The most commonly seen Haemoglobin genotype variants include HbAA, HbAS, HbAC, HbSS, HbSC and HbCC, but only five mutant hemoglobin genotype variants were observed in this study. Several studies on the prevalence of hemoglobin genotype variants in different Nigerian populations have been conducted in other parts of Nigeria.[11-15] but in Anambra state there is no such record on the echelon of hemoglobin variants among the subjects tested for haemoglobin genotype in Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra state southeast Nigeria. The study observed the percentage distribution of Hb genotype AA to be74.65%, which ranked the highest within our environment. A percentage distribution of 23.16% was reported for Hb genotype AS in the study and it ranked the second highest. Though the frequency of Hb genotype AA being significantly higher than that for Hb genotype AS, is in agreement with previous reports [4,5,15] that the normal haemoglobin genotype (HbAA), range from 55 to 75% and the sickle cell trait (HbAS) 20 to 30% in Nigeria [16] and 20 to 40% in Africa [17]. Our study, however, recorded lower frequencies for HbAC, SS and SC. This is perfectly in line with the previous findings from other studies in Nigeria such as in Imo state [18]. River state [12], residents of Lagos state6, residents of Sokoto, Sokoto State, Nigeria [7]. They also recorded the normal hemoglobin HbAA genotype as the most frequent of these genotypes. Other forms of Hb genotype variants (AS, AC, CC, SS, SC) were also seen in their studies [6,7,12,18], which were also seen in this study.

The study also showed percentage distribution of persons for haemoglobin genotype by sex (table 2). There were significance difference between males and females in the distribution of Hb genotype AA and Hb genotype AS ($P<0.05$). The difference might be due to the increased number of female subjects that visited the hospital and are more concerned about knowing their Hb genotype than the males. Again the females are more interested on the awareness and genetic counseling of sickle cell disease and other hemoglobinopathies since the Hb genotype test is mandatory for antenatal booking once they become pregnant. This difference between the males and the females were also observed on the study conducted in Ibadan8, which showed that the female subjects had higher frequency distributions in the entire hemoglobin variant than the male. There was no association between sex and hemoglobin variant distribution, due to the fact that hemoglobinopathies are not sex-linked as was showed in the study earlier reported [19], indicating that gender had no effect on the incidence of hemoglobin variants.

Conclusion

The analysis of 56,169 subjects haemoglobin genotype results concludes that Hb genotype genotype AA still maintained the highest ranked Hb genotype variants, followed by Hb genotype AS, HB genotype SS, Hb genotype AC and lastly Hb genotype SC in Anambra state, Southeast Nigeria.

Competing Interests

Authors have declared that no competing interests exist.

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