Nigerian Journal of Basic and Applied Sciences (2001) 10: 219-225

STUDY OF THE PREVALENCE OF SICKLE CELL DISEASE IN KANO METROPOLIS AND ITS SUBURBS IN NORTHERN NIGERIA

O.T. MUSTAPHA[1] and F.H. ABUBAKAR[2]

[1]Department of Biological Science
Bayero University, Kano. Nigeria
[2]Kano State Polytechnic, Kano, Nigeria.

ABSTACT

The incidence of the various sickle cell genotypes was investigated among a population of 1000 individuals randomly sampled in Kano Metropolis and its suburbs. The samples were analysed electrophoretically. Genotype Hb^SHb^S and Hb^SHb^C were found to be represented by 11.87% and 0.22% respectively while Hb^AHb^S and Hb^AHb^C were 40.33% and 1.51% respectively. The high incidence of the sickle cell disease was attributed to one or a combination of high degree of consanguinity, migration/gene flow, genetic isolates, polygamy and balance between mutation and selection.

INTRODUCTION

Sickle cell disease is a molecular disease of Haemoglobin. The disorders of haemoglobin, haemoglobinopathies, can be divided into two main groups: the structural variants – Hb^S, Hb^C and Hb^E, , and the disorder of synthesis, due to a structural variant and the manifestations can be traced back to the action of a mutant gene (Lehman and Hauntsman, 1974). The mutant haemoglobin Hb^S, Hb^C and Hb^E are associated with the sickling disorder of man. The abnormal haemoglobin is less soluble than normal haemoglobin A and therefore tends to crystallise out resulting in deformation of the cells which instead of being round become sickle-shaped.

Sickle cell disease is inherited as an autosomal recessive characteristic (Huck. 1923). The disease is manifested in persons who are homozygous for the gene. If the mutant haemoglobin is inherited from both parents, the genotype of such offspring would be SS, CC or EE. But if from only one parent, the genotype would be heterozygous AS, AC or AE (carrier). Also, an offspring can be compound heterozygote e.g. SC, SE etc.

It is a common misconception that Hb^S is limited to the Negro race whereas it is widely distributed among non-Negroes. In Africa, marked variation occur among people living in the same environment (Lehman and Raper, 1954a). In Nigeria, the sickle cell gene is also widely distributed. Hb^S is believed to be common in Northern Nigeria while Hb^C is distributed mainly in the Southern and Eastern Nigeria (19%) compared to about 0.5% in the North (Fleming et al; 1979). A population in the genetic sense is

not just a group of individuals, but a breeding group and the genetics of a population is concerned not only with the genetic constitution of the individuals but also with the transmission of the genes from one generation to the other. In a state of population equilibrium, the rate at which detrimental trait is produced by new mutation is balanced by the rate at which the trait is removed from the population by selection forces. Assuming that the mutation rate remains unchanged, then it would be expected that alleles confering greater biological fitness would tend to increase whereas those lowering biological fitness would tend to decrease.

Although, sickle cell gene was found to be most prevalent in Northern Nigeria (Fleming et al, 1979), there has been no records on the prevalence of the disease in Kano metropolis and its suburbs. This work, therefore, aims at studying the prevalence of the sickle cell disease (SS. CC. SC) and their respective traits (AS, AC) in Kano Metropolis with a view to highlighting the possible ways of reducing the incidence in the population, in order to minimise the human, social and economic cost of the disease.

MATERIALS AND METHODS

Electrophoresis chamber and cellulose accetate strips were prepared and set up at the Medical Laboratory of Murtala Mohammed Specialist Hospital in Kano State. Blood samples were collected randomly from individuals of Kano State Origin and transferred to plastic tubes containing 1.0ml EDTA (70g of Ethylene diamine tetra acetic acid + 50ml of distilled water) and mixed. Date, sex and age of each sample were recorded. Sixteen samples at a time were centrifuged at 600rpm for 5 minutes. The supernatant (the plasma) is discarded and the sediment (RBC) is suspended by shaking the tube gently for each sample for 1-2 seconds. A volume (0.5ml) of working solution [2.0ml KCN stock solution (12.5g potasium cyanide diluted to 250ml with distilled water) plus 0.3ml of EDTA and 120ml of distilled water] was pipetted into each of the tubes containing the sediment (RBC).

A pipette was used for the application of an extremely small amount (less than half a drop) of each haemolysate sample to each of the 16 segments on the plate. The wet cellulose acetate strip immersed in buffer (pH 8.6) [7.36g of diethyl barbituric acid + 41.20g of sodium barbitone + 4 litres of distilled water] was removed and excess buffer was removed by blotting the strip between two pieces of filter paper. Finally, the teeth of the shandom multiapplicator was placed on the buffer impregnated cellulose acetate strip along a line 1.5cm from one of the lateral margins on the strip. This was done gently but firmly so that the haemolysates will be applied directly on the same line of origin without shaking.

The cellulose acetate strip (containing haemolysate) was fixed on both shoulders of the electrophoresis chamber so that sample 1-16 were alligned paralled with the shoulders. The chamber was covered, the DC power pack was switched on and the

electrophoresis was carried out for 15 to 30 minutes. This time was enough for proper separation and movement of haemoglobins. The cellulose acetate paper was removed, allowed to dry and the different genotypes were identified from their movement or differentiation in electrophoresis. The result (genotype) of each sample was recorded.

The raw data was analysed using Lotus 123. Several kinds of analyses (age distribution, genotype distribution, genotype in percentage analysis of SS and SS + F etc) were carried out.

RESULTS AND DISCUSSION

Table 1 shows age distribution of the sampled genotypes and their proportions. While the genotype distribution of male: female ratio of the sampled population as obtained is presented in Table 2. Table 3 indicates the distribution of sicklers before and after selection while Table 4 showed genotype frequencies in the population.

From the study, the sickle cell genotype SS has a prevalence of 11.87%. Those carrying the genes AS are 40.53%. The frequency of these carriers is very close to those with normal genes AA with frequency of 45.87%. Those with SC are negligible with the frequency of 0.22 while the carriers AC have the frequency of 1.51%. In Nigeria, earlier studies showed that the Hb^c trait was most prevalent in Southern Nigeria (19%) compared to about 0.5% in the North (Fleming, et.al., 1979). It is suggested that this higher value of prevalence could be due to migration and intermarriage between Southerners and Kano indigenes.

The sickle cell trait SS is most prevalent in children within the age range of 0-10 years (Table 1). This is due to the fact that majority of the children with the disease die before reaching maturity. Allison (1954a) found that a calculated mutation rate was too low to balance the loss of B^s gene occurring in African environment. Genotype SC was found to be distributed only in children below 10 years. The sickle haemoglobin C disease (CC) was found in this study. The fact that there are too few female AC carriers may be used to explain why homozygous CC is absent in the population. It may also be due to chance or sampling error.

Sickle cell disease comprises of SS, SC, and CC and those with the disease plus heteocellular persistence of fetal haemoglobin (SS + F, SC + F, CC + F). In this study, only the SS + F was found. Sicklers with Hb^sHb^s + F have higher survival rate than those without F-factor because of the preferential survival of high Hb-F containing reticulocytes (Dover et al. 1978b). Out of the 171 (94.97%) SS found, 27 (14.71%) are SS + F. This low value of SS + F indicates that majority of the sicklers are still in danger of the deleterious effects of the gene.

Table 1: Age Distribution of the Sampled Genotypes and their Proportions

Age Range year	Frequency	%	AA	%	AS	%	AC	%	SS	%	SS+F	%	SC	%	CC	%
0-5	517	51.7	262	50.68	149	28.82	0	0	88	17	15	2.9	3	0.58	0	0
0-10	166	16.6	76	45.7	55	33.13	1	0.60	28	16	4	2.41	2	1.2	0	0
10-'15	105	10.5	57	54.29	33	31.43	1	0.95	10	9.3	4	3.81	0	0.0	0	0
15-20	78	7.8	42	53.85	23	29.49	1	1.28	10	13	2	2.56	0	0.0	0	0
20-25	66	6.6	36	54.55	21	31.82	1	1.52	6	9.1	2	3.03	0	0.0	0	0
25-30	41	4.1	21	51.22	18	43.9'0	1	2.44	1	2.4	0	0.0	0	0.0	0	0
30-35	19	1.9	6	31.58	12	63.16	1	5.26	0	0	0	0.0		0.0	0	0
35 above	8	0.8	2	25.00	50	62.5	0	0.00	1	13	0	0.0	0	0.0	0	0
	1000	100	502	36..95	316	324.25	6	12.1	144	80	27	14.7	5	1.78	0	0
Proportion				45.87		40.53		1.51		10		1.84		0.22		0

Table 2: Genotype Distribution of Male and Female Proportions of the sampled Population

Genotype	Frequency	%	Male	Female
AA	502	50.2	236	266
AS	316	31.6	153	163
SS	171	17.1	72	99
AC	6	0.6	4	2
SC	5	0.5	2	3
CC	0	0	0	0

In the analysis of sicklers before and after selection (Table 3), it was assumed that adults from 15 years and above were the few selected by the forces of selection on the mutant gene. Children below 15 years were found to have genotype frequency of 5.426% while the adults above 15 years have frequency of 4.606%. When the adult genotype frequency was added to those with fetal haemoglobin (SS + F), there was a total of 6.45% selected sicklers in the population, which is still very high

Table 3: Distribution of Sticklers Before and After Selection

BEFORE SELECTION		AFTER SELECTION	
Age range (yrs)	Frequency	Age Range (yrs)	Frequency
0.5	17.02	15-20	12.82
5-10	16.87	20-25	9.09
10-15	9.52	25-30	2.44
		30-35	0.00
		35 above	12.5
Proportion (%)	43.41		36.85
	5.426		4.606

Total frequency after selection = 1.840 9SS +F) + 4.606 = 6.446%

Table 4: Genotype Frequencies in the Population

	Normal	Frequency	Carrier	Frequency	Sicklier	Frequency
Genotype	AA	45.87	AS	40.53	SS	11.87
			AC	1.51	SC	0.22
Proportion%		45.87		42.04		12.09

The selective advantage of heterozygotes (AS) over normal hmozygotes (AA) must have led to the high frequency of heterozygotes in the preceding generation in Kano metropolis. This probably led to high frequency of affected homozygotes in this generation. Comparing the frequency of the trait (AS) 29% in Garki District of Northern Nigeria and the frequency of 17% in Ibadan (Fleming et al., 1984) with the frequency (40.53%) found in Kano metropolis, it can be observed that the frequency is high in this study.

It can therefore be concluded that the high frequency of sicklers found in this study is due to one or a combination of the following:

1. High degree of consanguinity: Hausa/Fulani culture allows for marriage between relations, and this will decrease the proportion of heterozygotes and increase that of homozygotes.

2. Migration/gene flow: Kano, being a commercial centre, most dwellers of the metropolis were immigrants.

3 Genetic isolates and random genetic drift: In Kano Metropolis, there are several isolated groups such as the Galadanchis, Yakasai's etc. and marriage occur
within each group.

4. Polygamy which promotes homozygosity.

5. Balance between mutation and selection.

It is recommended that vigorous enlightenment campaign should be mounted to educate people on the disease.

REFERENCES

Allison, A.C. (1954a) Notes on Sickle cell polymorphism.Ann. Hum. Genet. 19: 39-51.

Dover, G.T., S.H. Boyer, S. Charache,and K. Heintzelman (1978b). Individual variation in the production and survival of F cells in Sickle cell disease. N. Engl. J. Med. 299: 1428-1435.

Fleming, A.F., J. Storey, L. Molineaux, E.A. Iroko, and E.D.E. Attai (1979).Abnormal Haemoglobins in the Sudan Savanna of Nigeria. I. Prevalence of haemoglobins and relationships between sickle cell trait, malaria and survival. Ann. Trip. Med. Parasitol. 73: 161-172.

Fleming, A.F., K.A. Harrison, N.D. Broggs. E.D.E. Attai, G.B.S., Ghatoura, in the Guinea Savanna of Nigeria. Ann. Trop. Med. Parasitol. 78: 395-404. E.A.

Akintunde, and N. Shah, (1984). Anaemia in young primigravidae

Huck, J.G. (1923). Sickle cell anaemia. Bull. Johnshopkin Hosp. 34: 335-344.

Lehman, H and A.B., Rasper, (1984A). Maintenance of high sickling rate in an African Community. Br. Med. J. 2: 336-346.

Lehman H. and R.G. Huntsman, (1974). Mans Haemoglobins (2nd Ed.) North Hol. Publishing Company.