

**DUFFY BLOOD GROUP DISTRIBUTION AMONG PATIENTS IN A MALARIA
ENDEMIC REGION.**

Abstract:

Background: It was noted since in the 1920s that Black Africans had some intrinsic resistance to infection with malaria. Duffy negative status is suggested to play a role in resistance to malaria infection and has been reported with higher frequencies in countries where there is a high incidence of *Plasmodium vivax* malaria. We carried out this study to find out the distribution of Duffy blood group among patients in a tertiary hospital.

Study design: two hundred and twenty nine hospitalized patients requiring a red cell transfusion with age range of between 1 year and 75 years and mean age of 27.3 years, were recruited for the study.

Materials and Method: Three milliliters of whole blood was collected from each subject into an EDTA anticoagulated tubes. The red cell was typed for Duffy antigen using potent antisera from Lorne Laboratory UK according to the manufacturer's instructions.

Results: This study reported that 19.2% were Duffy positive (Fya+b-, Fya-b+ and Fya+b+ with respective prevalence of 7.4%, 4.4% and 7.4%) while 80.8% (61.1% Females and 19.7% Males) of the patients were Duffy negative (Fy a-b-). The prevalence of Duffy negative was highest among age group 21-30 with 26.2%, followed by age group 31-40 with 17.5% and the least was age group 41 – 50 years with 3.5%. The prevalence of Duffy negative among the three ethnic groups of Hausa, Igbo and Yoruba was 180(78.6%), 2(0.9%) and 3(1.3%) respectively.

24 **Conclusion:** We concluded that we now have Duffy positive group in Nigeria a potential risk
25 to *P. vivax* infection and recommend that the Nigeria government should carry out an
26 epidemiological study on the prevalence of *Plasmodium vivax* and *Plasmodium knowlesi*.

27 **Key words:** Duffy, Blood group, Distribution, Malaria, Sokoto, Nigeria.

28 **Introduction:**

29 The Duffy antigen is located on the surface of red blood cells and is named after the patient in
30 which it was discovered. The protein encoded by this gene is a glycosylated membrane
31 protein and a non-specific receptor for several chemokines. The Duffy antigen receptor gene
32 (gp-Fy; CD234) is located on the long arm of chromosome 1 (1.q22-1.q23) and was cloned in
33 1993.⁽¹⁾ The protein is also the receptor for the human malarial parasites *Plasmodium vivax*
34 and *Plasmodium knowlesi*.⁽²⁾ In areas of West Africa, there is a high frequency of the Fy (a-
35 b-) phenotype. This has prevented *P. vivax* malaria from becoming endemic in West Africa.⁽³⁾
36 It was noted in the 1920s that Black Africans had some intrinsic resistance to infection with
37 malaria but the basis for this was then unknown, however, Duffy negative status is suggested
38 to play a role in resistance to malaria infection⁽⁴⁾ and has been reported with higher
39 frequencies in countries where there is a high incidence of *Plasmodium vivax* malaria.⁽⁵⁾ On
40 erythrocytes, the Duffy antigen acts as a receptor for invasion by the human malaria parasites
41 *P. vivax* and *P. knowlesi*. Duffy negative individuals whose erythrocytes do not express the
42 receptor are believed to be resistant to merozoite invasion, although *P. vivax* infection has
43 been reported in Duffy negative children in Kenya, Madagascan people, Angola and
44 Equatorial Guinea, suggesting a role in resistance to disease, not infection.^(6,4,5) The Duffy
45 antigen gene was the fourth gene associated with the resistance after the genes responsible for
46 sickle cell anaemia, thalassemia and glucose-6-phosphate dehydrogenase.⁽⁷⁾ In 1950 the
47 Duffy antigen was discovered in a multiply transfused haemophiliac whose serum contained
48 the first example of anti-Fya antibody.⁽⁷⁾ In 1951 the antibody to a second antigen, Fyb, was

49 discovered in serum. Using these two antibodies three common phenotypes were defined: Fy
50 (a+b+), Fy (a+b-), and Fy (a-b+).⁽⁷⁾

51 There exist differences in the racial distribution of the Duffy antigens, it was found that the
52 overwhelming majority of Blacks had the erythrocyte phenotype Fy(a-b-), 68% in African
53 Americans⁽⁴⁾ and 88-100% in African Blacks (including more than 90% of West African
54 Blacks). This phenotype is exceedingly rare in whites. The presence of this antigen has been
55 used to detect genetic admixture. Overall the frequencies of Fya and Fyb antigens in
56 Caucasians are 66% and 83% respectively, in Asians 99% and 18.5% respectively and in
57 Blacks 10% and 23% respectively. The frequency of Fy3 is 100% Caucasians, 99.9% Asians
58 and 32% Blacks. Phenotype frequencies are: Fy(a+b+): 49% Caucasians, 1% Blacks, 9%
59 Chinese; Fy(a-b+): 34% Caucasians, 22% Blacks, <1% Chinese; Fy (a+b-): 17% Caucasians,
60 9% Blacks, 91% Chinese.^(4,5,6) A Duffy negative blood recipient may have a transfusion
61 reaction if the donor is Duffy positive. Since most Duffy-negative people are of African
62 descent, blood donations from people of Black African origin are important to transfusion
63 banks. There is no information regarding the distribution of Duffy blood group in most of the
64 African countries including Nigeria especially in Sokoto, Northwestern Nigeria. We intend to
65 find the distribution of the Duffy antigens among hospitalized patients requiring a red cell
66 transfusion in a tertiary hospital in malaria endemic region.

67 **Study design and study site:**

68 The study was a cross-sectional descriptive study to find the effect of transfusion on the
69 development of alloantibodies among 229 consecutively- recruited patients from a tertiary
70 hospital in Sokoto Nigeria. Sokoto is the capital city of Sokoto state. Sokoto State is located
71 in the extreme Northwest of Nigeria, near to the confluence of the Sokoto River and the Rima
72 River. With an annual average temperature of 28.3 °C (82.9 °F), Sokoto is, on the whole, a

73 very hot area. Report from the 2007 National Population Commission indicated that the state
74 had a population of 3.6 million.⁽⁸⁾ The two major languages in the state is Hausa and Fulfulde
75 which is spoken among the Fulani. The main occupation of the people is grain production and
76 animal husbandry.

77 **Materials and Method:**

78 Three milliliters of whole blood was collected from each subject into an EDTA
79 anticoagulated tubes by a clean venipuncture. The blood was washed with phosphate buffered
80 saline and then typed for Duffy antigen using potent antisera from Lorne Laboratory UK as
81 described below. The laboratory investigations were carried out at the Faculty of Medical
82 Laboratory Science, Department of Haematology and Blood Transfusion Science of the
83 Usmanu Danfodiyo University Sokoto.

84 **Ortho Biovue typing technique for Duffy antigens:**

- 85 i. A 0.8% suspension of washed cells in 0.8% Ortho red cell diluent was prepared.
- 86 ii. A 50ul of suspension of washed test cells and 40ul of the Lorne reagent was
87 dispensed into the appropriate Ortho Biovue system cassettes (AHG/Coombs)
88 reaction cambers.
- 89 iii. The cassette was incubated for 15 minutes at 37°C.
- 90 iv. The cassette was centrifuged for 5 minutes in an Ortho Biovue system centrifuge.
- 91 v. The result was read macroscopically for agglutination which indicated the
92 presence of the appropriate red cell antigen by the red cells been trapped at the top
93 of the micro tube.

94

95 **Selection criteria:**

96 Ethical clearance was obtained from the ethical committee of the Specialist hospitals, Sokoto.
97 While written informed consent was sought from all participants in this study. All consenting

patients in whom a red cell transfusion was indicated were eligible for recruitment into the study. All non- consenting patients were all excluded in this study.

Data analysis:

The sociodemographic information was collected using a pre-validated structured questionnaire administered to the patients. The data obtained were presented in tabular forms and was analyzed using statistical software (SPSS version 20).

Result:

Table 1 below showed that 19.2% were Duffy positive (Fya+b-, Fya-b+ and Fya+b+ with respective prevalence of 7.4%, 4.4% and 7.4%) while 80.8% (61.1% Females and 19.7% Males) of the patients studied were Duffy negative (Fy a-b-). In table 2, the prevalence of Duffy negative was found to be highest among ages 21-30 with 26.2%, followed by ages 31-40 with 17.5%. Table 3 showed the prevalence of Duffy negative among three ethnic groups of Hausa, Igbo and Yoruba as 180(78.6%), 2(0.9%) and 3(1.3%) respectively.

Table 1. Distribution of Duffy phenotype of the patients based on gender.

Gender	Duffy phenotype				Total
	Fya-b-	Fya+b-	Fya-b+	Fya+b+	
Male	19.7%	1.7%	0.9%	1.7%	24.0%
Female	61.1%	5.7%	3.5%	5.7%	76.0%
Total	80.8%	7.4%	4.4%	7.4%	100.0%

The above table showed that 80.8% (61.1% Females and 19.7% Males) of the patients studied were Duffy negative (Fy a-b-), while 19.2% were Duffy positive (Fya+b-, Fya-b+ and Fya+b+ with respective prevalence of 7.4%, 4.4% and 7.4%).

Table 2. Distribution of Duffy phenotype among the patients based on age groups.

Age groups	Duffy phenotype				Total
	Fy (a-b-)	Fy (a+b-)	Fy (a-b+)	Fy (a+b+)	
< 10	13.5%	0.4%	0.4%	0.9%	15.3%
11 - 20	13.5%	1.3%	0.4%	2.2%	17.5%
21 - 30	26.2%	3.1%	2.2%	2.6%	34.1%
31 - 40	17.5%	1.3%	0.9%	0.9%	20.5%
41 - 50	3.5%	0.4%	0.4%	0.4%	4.8%
≥ 51	6.6%	0.9%	0.0%	0.4%	7.9%
Total	80.8%	7.4%	4.4%	7.4%	100.0%

Table 2 above showed the prevalence of Duffy negative to be highest among ages 21-30 with 26.2%, followed by ages 31-40 with 17.5%.

Table 3. Distribution of Duffy phenotype among the patients based on ethnicity.

Ethnicity	Duffy phenotype				Total
	Fy (a-b-)	Fy (a+b-)	Fy (a-b+)	Fy (a+b+)	
Igbo	2(0.9%)	0(0.0%)	0(0.0%)	0(0.0%)	2(0.9%)
Hausa	180(78.6%)	17(7.4%)	9(3.9%)	17(7.4%)	223(97.4%)
Yoruba	3(1.3%)	0(0.0%)	1(0.4%)	0(0.0%)	4(1.7%)
Total	185(80.8%)	17(7.4%)	10(4.4%)	17(7.4%)	229(100.0%)

Table 3 above showed the prevalence of Duffy negative among three ethnic groups of Hausa, Igbo and Yoruba as 180(78.6%), 2(0.9%) and 3(1.3%) respectively.

127

128 **Discussion:**

129 In this present study, we observed Fya and Fyb prevalence of 14.8% and 11.8% respectively
130 with 85.2% and 88.2% of the study population lacking the respective antigens. Erhabor *et al.*,
131 reported a much lower prevalence among pregnant women in the same study area. The reason
132 for the difference was attributed to the difference in the methods used and the type of study
133 population.⁽⁹⁾ In their study, a less sensitive tube method was used and the study population
134 was among antenatal women, while in this study, we applied the gel microtubules method
135 which is more sensitive, and our population comprises of both males and females patients and
136 adults and children. Our finding is also higher than previously reported which observed Duffy
137 antigens among 2.38% of Sudanese patients.⁽¹⁰⁾ Our finding is however very lower than
138 reported values among the whites which indicated that Fya and Fyb antigens were relatively
139 frequently in Caucasians, (66% and 83%) and Asians (99% and 18.5%) but far less
140 commonly in Blacks (10% and 23%) respectively.⁽⁷⁾

141 The distribution of the Duffy phenotype in this our present study was 19.2% Duffy positive
142 (Fya+b-, Fya-b+ and Fya+b+ with respective prevalence of 7.4%, 4.4% and 7.4%) and 80.8%
143 (61.1% Females and 19.7% Males) Duffy negative (Fy a-b-). These values are in agreement
144 with the values suggested for Black population of 68.0%, 1.0%, 9.0% and 22.0 respectively,
145 but it varies from the values obtain for Indians, white and the Chinese in which high
146 prevalence of Fya⁺b⁻, Fya⁺b⁺, and Fya⁺b⁻ was reported. Fya⁻b⁻ prevalence was reported as
147 0.0% or very rare in these ethnic groups,⁽¹¹⁾ this invariably meant that it is difficult to source
148 for Duffy negative blood for Blacks resident among the Whites who required blood
149 transfusion. It also showed that Duffy negative blood are in great supply among the Black
150 population.

The prevalence of Duffy negative was observed to be highest among ages 21-30 with 26.2%, followed by ages 31-40 with 17.5%. These age groups are considered to be in the blood donor age bracket and can provide the general population with the much needed Duffy negative blood especially to transfusion dependant patients and pregnant women. Duffy antigens are clinically significant antigens and when transfused to an individual that lacks it, can cause the production of clinically significant alloantibodies against this antigens in the individual. These alloantibodies can complicate blood transfusion among blood transfusion dependent patients and also complicates pregnancy out come in women.

Duffy negative status is suggested to play a role in resistance to malaria infection.⁽⁴⁾ Duffy negative has been reported with higher frequencies in countries where there is a high incidence of *Plasmodium vivax* malaria.⁽⁵⁾ Blood groups antigens are the product of genes. Evolutionary pressure from various environmental pathogens is thought to be responsible for the generation of genetic variants, resulting in survival advantage. A well-known example are individuals whose phenotype is Fy (a-b-) and lack glycol protein-Fy on their erythrocytes, preventing the invasion of malaria *Plasmodium vivax* parasite.⁽¹²⁾ Nigeria generally is considered a malaria endemic region, although *P. falciparum* is considered the most dominant species, the high prevalence of Duffy negative obtained in our study for all the ethnic groups studied may not be unrelated to the good love of nature providing resistance against double infection by other species of malaria. However, because there exist 19.2% of Duffy positive in the population which possess a potential risk for *P. vivax* and *P. knowlesi* infection, we therefore recommend the followings: for the Nigerian government to carry out an epidemiological study on the prevalence of *P. vivax* and *P. knowlesi* infection.

Conclusion:

We concluded that we now have Duffy positive group in Nigeria a potential risk to *P. vivax* infection.

177 **References**

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