

## Malaria, Haemoglobin Genotypes and ABO Blood Groups in Ogbomosho, Nigeria

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**Abstract:** This study assessed the prevalence of malaria parasitemia and severe malaria and their association with haemoglobin genotypes and ABO blood groups. Medical records of 501 students who attended or were admitted during the period of study in LAUTECH Teaching Hospital were used. Subjects with sickle cell disease (HbSS, HbSC) showed the highest prevalence of both malaria parasitemia and severe malaria followed by subjects with haemoglobin AA. Sickle cell trait subjects (HbAS, HbAC) had the lowest prevalence. Also subjects with blood group O had a higher prevalence of malaria parasitemia but a lower prevalence of severe malaria when compared with the non O blood groups. The association of sickle cell disease with high prevalence of malaria parasitemia and severe malaria confirms the susceptibility of the sickle cell gene in the homozygous state to easy fragility of Red Blood Cells (RBCs). The association of blood group O with less prevalence of severe malaria confirms the protective role of antigen O in impairing rosetting and vascular cytoadhesion of parasitized RBCs. The association of blood group O with high prevalence of malaria parasitemia might suggest that O antigen is more susceptible to malaria infection than non O antigens but less susceptible to severe malaria.

**Key words:** Prevalence, malaria, genotype, blood group, rosette formation, vascular adhesion

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### INTRODUCTION

Malaria is a great tropical and subtropical public health problem. It is probably the leading cause of death in the world despite global efforts to control it (Pickett and Hallon, 1990; Smyth, 1994). It may also occur in the temperate region with its dissemination diminishing from the equator (Bienzle *et al.*, 1980; Werner and Mathys, 1987). It is estimated that there are 300-500 million new cases every year with 1.5-2.7 million deaths worldwide, particularly in Africa (WHO, 1992).

Malaria, a protozoan infection caused by *Plasmodium* species transmitted by anopheles mosquitoes has been associated with high morbidity and mortality through anaemia, cerebral complications and other mechanisms (Uneke, 2006). Malaria is the second leading disease, following Acquired Immunodeficiency Syndrome (AIDS) which shows a significant rising tendency (Uneke, 2006). Despite advances in the understanding of the pathogenic and clinical aspects of malaria, it is still not well known why some people tolerate malaria infection with few or no symptoms whereas others are severely affected (Azeez and Raji, 2007).

Genetic markers such as haemoglobin genotypes and blood groups have been associated with various disease conditions including malaria. These markers are not linked to the incidence of malaria but have been implicated with rosette formation (Fischer-Hoch, 1998; Rowe *et al.*, 2007) and cytoadhesion (Cserti and Dzik, 2007). Dacie and Lewis (1991) also reported that antigens present on Red Blood Cells (RBCs) are involved in the susceptibility of the RBC to plasmodium species.

The purpose of this study was to assess the prevalence of malaria and its distribution based on haemoglobin genotypes and ABO blood groups.

### MATERIALS AND METHODS

**Study area:** This research was carried out in Ladoke Akintola University of Technology (LAUTECH) Medical Centre, Ogbomosho, Oyo state, Nigeria.

**Subjects and methods:** Data were collected from the medical records of 501 LAUTECH students who attended or were admitted to the university medical centre between 2007 and 2009.

**Statistical analysis:** Data were analyzed by Chi-square with the significance level set at  $p < 0.05$ . Data are presented as number (percentage).

**Ethics:** The procedures followed were in accordance with the ethical standards of the Ladoke Akintola University of Technology Committee guidelines on human experimentation and with the Helsinki Declaration of 1975, as revised in 1983.

## RESULTS AND DISCUSSION

Table 1 shows the prevalence of malaria parasitemia among both sexes. The result revealed that out of 501 cases, 335 (66.87%) was positive for malaria parasitemia. Out of the 335 subjects positive for malaria parasitemia, 162 (48.36%) were male and 173 (51.64%) were female. The prevalence of malaria was not associated with sex ( $p = 0.254$ ).

Table 2 shows that the distribution of malaria parasitemia by haemoglobin genotypes. The frequencies of malaria parasitemia were 76.57, 42.00, 37.50, 100 and 83.33% for haemoglobin genotypes AA, AS, AC, SS and SC, respectively. This shows that malaria parasitemia is associated with haemoglobin genotype ( $p = 0.0000$ ).

Table 3 shows that severe malaria is associated with haemoglobin genotype ( $p = 0.0000$ ). The frequencies of severe malaria were 16.57, 4.00, 2.50, 80.00 and 83.33% for AA, AS, AC, SS and SC, respectively.

Table 1: Prevalence of malaria based on gender

Gender	+ve for parasite (%)	-ve for parasite (%)	Total (%)
Male	162 (48.36)	90 (54.22)	252 (50.30)
Female	173 (51.64)	76 (45.78)	249 (49.70)
Total	335 (66.87)	166 (33.13)	501

+ve = Positive, -ve = Negative;  $\chi^2 = 1.299$ ,  $p = 0.254$

Table 2: Distribution of malaria parasitemia by haemoglobin genotype

Haemoglobin genotype	No infected (%)	No uninfected (%)	Total no examined
AA	268 (76.57)	82 (23.43)	350
AS	42 (42.00)	58 (58.00)	100
AC	15 (37.50)	25 (62.50)	40
SS	5 (100.00)	0 (0.00)	5
SC	5 (83.33)	1 (16.67)	6

No = Number,  $\chi^2 = 61.57$ ,  $p = 0.000$

Table 3: Distribution of severe malaria by haemoglobin genotype

Haemoglobin genotype	No infected (%)	No uninfected (%)	Total no examined
AA	58 (16.57)	292 (83.43)	350
AS	4 (4.00)	96 (96.00)	100
AC	1 (2.50)	39 (97.50)	40
SS	4 (80.00)	1 (20.00)	5
SC	5 (83.33)	1 (16.67)	6

No = Number,  $\chi^2 = 55.39$ ,  $p = 0.000$

Distribution of malaria parasitemia and severe malaria by ABO blood group system is shown in Table 4 and 5. Blood group O had the highest frequency of malaria parasitemia (85.71%) but the lowest frequency of severe malaria (7.5%). Blood group AB had the lowest frequency of malaria parasitemia (33.33%). Blood group A had the highest frequency of severe malaria (24.34%).

Since, the discovery of the ABO blood group system, it has remained the most clinically relevant blood group system and has been associated with various disease conditions. Similarly, haemoglobin genotypes have also been linked with various pathologic conditions. There have been varying reports on the prevalence of the ABO blood group system and haemoglobin genotypes. This study confirms that blood group O is the most prevalent while blood group AB is the least prevalent. This is in consonance with previous studies (Uzoegwu and Onwurah, 2003; Anees and Mirza, 2005; Jeremiah, 2006; Bakare *et al.*, 2004; Odokuma *et al.*, 2007; Abdulazeez *et al.*, 2008; Epid *et al.*, 2008; Akhigbe *et al.*, 2009). The results from the study show that haemoglobin genotype AA is the most prevalent while SS is the least. Though, the prevalence shown in this study is limited because it only accounts for students who attended or were admitted in the university medical centre, it is similar to the reports of previous studies (Nwafor and Bamigo, 2001; Moormann *et al.*, 2003; Akhigbe *et al.*, 2009).

This study shows that subjects with sickle cell disease (HbSS and HbSC) were most susceptible to malaria while those with sickle cell traits (HbAS and HbAC) were least susceptible and HbAA subjects were inbetween. Similarly, severe malaria was most prevalent in subjects with sickle cell disease and least among those with sickle cell traits. This is in agreement with previous studies (Fleming *et al.*, 1985; Modiano *et al.*, 2001; Uzoegwu and Onwurah, 2003; Verra *et al.*, 2007). This is due to the substitution of hydrophilic amino acid, glutamate with hydrophobic amino acid, valine (as in HbS)

Table 4: Distribution of malaria parasitemia by ABO blood group system

Distribution	A	B	AB	O	Total
Infected (%)	53 (46.09)	40 (40.00)	2 (33.33)	240 (85.71)	335 (66.87)
Uninfected (%)	62 (53.91)	60 (60.00)	4 (66.67)	40 (14.290)	166 (33.13)
Total	115	100	6	280	501

$\chi^2 = 102.9$ ,  $p = 0.000$

Table 5: Distribution of severe malaria by ABO blood group system

Infection	A	B	AB	O	Total
Infected (%)	28 (24.34)	22 (22.00)	1 (16.67)	21 (7.5)	72 (14.37)
Uninfected (%)	87 (75.66)	78 (78.00)	5 (83.33)	259 (92.5)	429 (85.63)
Total	115	100	6	280	501

$\chi^2 = 24.80$ ,  $p = 0.000$

or lysine (as in HbC) causing increased binding affinity between haemoglobin molecules with polymerization of haemoglobin deforming RBCs which are rapidly cleared from the circulation. Unlike in homozygous state (sickle cell disease), the heterozygous states (sickle cell traits) have a greatly reduced chance of severe malaria infection and anaemia. However, this is not in agreement with the study of Amoo *et al.* (2008) that reported the highest prevalence of malaria parasitemia among subjects with HbAA and least with HbSS.

Another interesting finding of this study is the association of malaria infection with ABO blood group system. The frequencies of malaria infection for blood groups A, B, AB and O were 46.09, 40.00, 33.33 and 85.71%, respectively and 24.34, 22.00, 16.67 and 7.5%, respectively for severe malaria. This study shows that blood group O is associated with a higher prevalence of malaria parasitemia ( $\chi^2 = 99.86$ ;  $p = 0.000$ ) and a lower prevalence of severe malaria ( $\chi^2 = 23.10$ ;  $p = 0.000$ ) when compared with non O blood groups. This is similar to previous studies (Fischer and Boone, 1998; Cserti and Dzik, 2007; Rowe *et al.*, 2007; Adam *et al.*, 2007; Amoo *et al.*, 2008; Epid *et al.*, 2008) which reported that blood group O had the highest prevalence of malaria parasitemia but the lowest susceptibility to severe malaria infection. Blood group AB had the lowest prevalence of malaria parasitemia and the non O blood groups more susceptible to severe malaria. This is due to the ability of O antigen to impair sequestration and rosette formation, thus reducing adherence of parasitized RBCs to the vasculature with consequent improvement of blood flow.

### CONCLUSION

This study confirms that sickle cell disease is associated with high prevalence of malaria parasitemia and severe malaria. Blood group O might be more susceptible to malaria infection but convincingly less susceptible to severe malaria. The relationship between high prevalence of malaria infection, severe malaria and sickle cell disease is due to the sickling gene which is easily deformed and rapidly cleared from the circulation. The protective role of blood group O against severe malaria infection is associated with its ability to impair rosetting and vascular cytoadherence.

### RECOMMENDATION

The researchers therefore, recommend that more effort is made to promote the life quality of patients

susceptible to severe malaria by mechanisms aimed at stabilizing the haemoglobin and impairing rosetting and vascular cytoadherence of the RBCs.

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