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Influence of ABO blood groups in malaria infected pregnant women in Enugu, South-East, Nigeria.

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Abstract

Malaria infection during pregnancy is a significant public health problem with substantial risks for the pregnant woman, her fetus, and the new-born child. Malaria-associated maternal illness and low birth weight is mostly the result of *Plasmodium falciparum* infection and occurs predominantly in Africa. The influence of ABO blood groups on malaria infected pregnant women were investigated in Enugu, South-East, Nigeria. Two hundred and fifty women consisting of 200 pregnant women and 50 non-pregnant women (control) aged 19 to 35 years participated in the study. After obtaining informed consent from the participants, their blood samples were collected for total white blood cell, blood grouping and blood smears for malaria parasites. In the blood groups A, B, AB and O, the malaria parasite density increased significantly in the first, second and third trimesters when compared with the control respectively. Primigravida recorded the highest incidence with highest number of parasite positivity. Blood group O+ recorded the highest incidence but group AB+ recorded highest parasite positivity in the second trimester. The study has demonstrated more malaria parasite densities in blood groups AB+ and O+ of pregnant women in first and second trimester. Since group AB has both A and B antigens and group O has both anti-A and anti-B antibodies, these findings may suggest that ABO blood group has no influence on malaria parasites in pregnancy.

Keywords: ABO blood groups, Malaria, Pregnant women.

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Introduction

The ABO blood group system is arguably the best known, and yet the most functionally mysterious, genetic polymorphism in humans. In clinical practice, ABO is the most important system for blood group compatibility [1]. A total of 29 human blood group systems are now recognized by the International Society of Blood Transfusion (ISBT). A complete blood type would describe a full set of 29 substances on the surface of RBCs and an individual's blood type is one of the many possible combinations of blood group antigens [2]. Almost always, an individual has the same blood group for life; but very rarely an individual's blood type changes though addition or suppression of an antigen in infection, malignancy or autoimmune disease [3]. An example of this rare phenomenon is the case of Demi-lee Brennan, an Australian citizen, whose blood group changed after a liver transplant. Another more common cause of blood type change is bone marrow transplant [4].

Malaria infection is the most important of all tropical diseases, causing many deaths and much morbidity. Malaria is a mosquito-borne infection disease of humans and other animals caused by eukaryotic prostists of the genus *Plasmodium*. The disease results from the multiplication of *Plasmodium* parasites within the red blood cells, causing symptoms that typically include fever and headache, in severe cases progressing to coma or death [5]. It is widely distributed in the tropical and subtropical regions, including much of sub-Saharan Africa, Asia and the America. There are four species of human malaria, all caused by species of the genus *Plasmodium*: *Plasmodium falciparum* (*P. falciparum*), *P. vivax*, *P. ovale* and *P. malarial* [6].

Pregnancy is the fertilization and development of one or more offsprings known as an embryo or foetus in a woman's uterus [7]. Pregnancy is the period of time, lasting approximately 280 days from the first day of the last menstrual period. Human pregnancy is the most studied of all mammalian pregnancies.

One scientific term for the state of pregnancy is gravidity, Latin word for "heavy" and a pregnant female is sometimes referred to as a gravid [7]. Similarly, the term parity is used for the number of previous successful live births medically, a woman who has never been pregnant is referred to as a nulligravida; a woman who is (or has been only) pregnant for the first time as a primigravida and a woman in subsequent pregnancies as a multigravida or multiparous [8,9]. In many societies human pregnancy is divided into three trimester periods (first, second and third trimesters) as a means to simplify reference to the different stages of prenatal development [10].

The influence of ABO blood groups on malaria in pregnancy remains a major challenge in Africa [11]. The presentation of malarial during pregnancy varies according to the pre-existing immunity of the mother [12]. Women living in area of low transmission have little immunity to malaria which can cause severe syndromes, such as cerebral malaria and pulmonary oedema. In contrast, those who live in areas of stable malaria transmission enjoy greater immunity and experience fever symptoms during episodes of malaria although they commonly develop severe anemia as a result of the infection [9]. The increased risk of parasitaemia infection imposes a heavy burden on the health of mothers and new-borns, contributing to maternal anaemia, low birth weight and infant mortality [13-15]. At present, available preventive and therapeutic tools can only achieve a partial reduction in the health hazard caused by malaria [16]. The protective role of several erythrocytic variants some of them related to blood groups is one of the best examples of this genetic modulation [17].

The influence of ABO blood groups on malaria in pregnancy have not been documented in our locality and may constitute a major challenge in Africa. Due to high mortality rate of malaria infection among pregnant women and paucity of data on the influence of ABO blood groups on malaria in pregnancy, the present study was designed. The aim of the study was to investigate the influence of ABO blood groups in malaria infected pregnant women in Enugu, South-east, Nigeria. The specific objectives were to determine the: (i) distribution of different parities with positive malaria parasites in pregnant women and non-pregnant women control, (ii) frequency and percentage positivity of malaria parasites in different blood groups of pregnant women, (iii) frequency and parasite density in different blood groups at different gestational age of pregnant women, (iv) age distribution of the pregnant women and non-pregnant control women and (v) malaria parasite density of the different trimesters and different ABO blood groups.

Materials and Methods

Recruitment of patients

The study was reviewed and approved by the Health Research and Ethical Committee of the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu, Nigeria. The study adopted the survey design. Two hundred and fifty women, comprising of 200 pregnant women aged 19 to 35 years, attending antenatal clinic at the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu and 50 non-pregnant women (control) participated in the study.

Exclusion/inclusion criteria

Pregnant women (aged 19 to 35 years) were included in this study while pregnant women who refused to participate in the study and those below the age of 19 years and above the age of 35 years were excluded from the study.

Collection of blood samples

After obtaining informed consent from the participants, they were made to sit down comfortably, and the area of skin from which the blood was to be drawn (upper arm) was tied with tourniquet and sterilized with cotton wool moistened with 70% alcohol and puncture was made with sterile needle and plastic syringe. Venous blood sample (2.0 ml) was collected from each participant into ethylene diamine tetra acetic acid containers for blood grouping; total white blood cell count and blood smear for microscopy and malaria parasite density calculations.

Biochemical analysis

The ABO and Rhesus D blood grouping were carried out on the participants using standard procedures as described by Dacie and Lewis [18]. Blood smears (thick and thin blood films) were made on clean grease free slides and labelled accordingly as recommended by World Health Organisation [19]. Blood smears (thick and thin films) were prepared using the Giemsa stain. The blood smears were read for 200 fields before declared negative. Parasite count was given by 500 white blood cells or by 1,000 red blood cells. All stages of the parasites were recorded (asexual and gametocytes). Total white blood cell count was done by the haemocytometer method [18].

Statistical analysis

The statistical analysis was done with Statistical Package for Social Sciences (SPSS) version 21 computer software. Data were subjected to descriptive statistics and analysed using student's t-test at 95% confidence interval.

Results

The results of the study were expressed in Tables 1-5. Table 1 shows the distribution of different parities in pregnant women with malaria parasites and control (n=250). The primigravida (n=118) recorded 48 (40%) positivity, the secundigravida (n=34) recorded 20 (16.7%) positivity, the multigravida (n=48) recorded 28 (23.3%) positivity while the non-pregnant control (n=50) recorded 24 (20.0%) positivity. The total positivity from the 250 participants was 120 (48.8%).

The frequency and percentage positivity of malaria parasites in different blood groups of pregnant women is as shown in Table 2. Blood group AB+ recorded the highest number of positivity

(n=32), followed by group O+ (n=20), A+ (n=16), B+ (n=12), AB- (n=8), B- and O- (n=4).

Table 3 shows the frequency and parasite densities in different blood groups at different gestational ages of pregnant women. Group AB recorded the highest parasite positivity in general and second trimester in particular. Group AB also recorded the highest parasite density in the study.

Table 4 shows the age distributions of the pregnant women and non-pregnant controls. The pregnant women between the ages 31 to 35 years occurs most (n=112), followed by 26 to 30 years (n=68) and the list 19 to 25 years (n=20).

Malaria parasite density of the different trimesters and different ABO blood groups of pregnant women is as shown in Table 5. The first trimester malaria parasite density (MP/Microliter) of group A (8.0 ± 2) increased significantly (P=0.015) when compared with the control (2.0 ± 1.0). The malaria parasite density (MP/Microliter) of group AB (6.2 ± 2) increased significantly (P=0.010) when compared with the control (2.4 ± 1.3). The malaria parasite density (MP/Microliter) of group O (20.6 ± 4) increased significantly (P=0.0075) when compared with the control (2.0 ± 0.4). Group O recorded the highest parasite density in the first trimester.

The second trimester malaria parasite density (MP/Microliter) of group A (5.2 ± 1.3) increased significantly (P=0.017) when compared with the control. The malaria parasite density (MP/Microliter) of group B (4.0 ± 1) increased significantly (P=0.027) when compared with the control. The malaria parasite density (MP/Microliter) of group AB (11.2 ± 2) increased significantly (P = 0.00045) when compared with the control. The malaria parasite density (MP/Microliter) of group O (10.8 ± 2) increased significantly (P=0.008) when compared with the control.

The third trimester malaria parasite density (MP/Microliter) of group AB (6.0 ± 0.8) increased significantly (P=0.012) when compared with the control. The malaria parasite density (MP/Microliter) of group O (4.4 ± 1) increased significantly (P=0.0285) when compared with the control.

Table 1. *The distribution of different parities with positive malaria parasites in pregnant women and non-pregnant control (n=250). Primigravida has the highest incidence with highest number of parasite positivity.*

Parity	Total	MP Positive	Percent positive
Primigravida	118	48	40
Secundigravida	34	20	16.7
Multigravida	48	28	23.3
Control	50	24	20
Total	250	120	48.8

Table 2. *The frequency and percentage positivity of malaria parasites in different blood groups of pregnant women. Blood group O+ has the highest incidence but group AB has highest parasite positivity.*

Blood groups	MP positive	MP negative	Total	Percent positive (%)
A^+	16	24	40	16.7
A^-	0	4	4	0
B^+	12	4	16	12.5
B^-	4	8	12	4.2
AB^+	32	8	40	33.3
AB^-	8	0	8	8.3
O^+	20	52	72	20.8
O^-	4	4	8	4.2
Total	96	104	200	-

Table 3. *The frequency and parasite density in different blood groups at different gestational age of pregnant women. Group AB recorded the highest parasite positivity in general and Second trimester in particular. Group AB also recorded the highest parasite density in the study.*

Blood groups	First trimester	Second trimester	Third trimester	Total	Parasite density (MP/microlitre)
A^+	3	8	5	16	3
A^-	0	0	0	0	0
B^+	3	6	3	12	3
B^-	1	2	1	4	2
AB^+	6*	16*	10*	32*	10 *
AB^-	1	4	3	8	1
O^+	10	6	4	20	2
O^-	1	2	1	4	1
Total	19	48*	29	96	
MP/microlitre	5	10 *	5	-	-

*(Significant increase when compared with the control)

Table 4. The age distribution of the pregnant women and non-pregnant control women.

Age (Y)	Pregnant	Non-pregnant	Total
19-25	20	20	40
26-30	68	15	83
31-35	112	15	127
Total	200	50	250

Discussion

Twenty-five million pregnant women are currently at risk for malaria. According to the World Health Organization (WHO), malaria accounts for over 10,000 maternal and 200,000 neonatal deaths per year. These figures may underestimate the impact malaria has in maternal morbidity and mortality. Adults who live in malaria-endemic regions generally have some acquired immunity to malaria infection as a result of immunoglobulin production during prior infections in childhood. This immunity diminishes significantly in pregnancy, particularly in primigravidas. Malaria in pregnancy contributes to low birth weight and increased infant mortality. Malaria also increases the chances of abortion, intrapartum foetal distress and meconium stained amniotic fluid. Malaria is an important cause of foeto-maternal morbidity during pregnancy.

The primigravida recorded the highest frequency of malaria infection in the study (Table 1). This may probably be attributed to sudden change in their body physiology thereby affecting their immune system and increasing the malaria infection [20]. Pregnant women of blood group AB recorded the highest frequency of malaria infection in the study (Table 2). This might probably be attributed to lack of the preformed antibodies by the blood group AB. The second trimester (Table 3) revealed high parasite density in groups AB and O which is higher than third trimester. This might be that treatments of malaria have started at this stage of pregnancy. However, the second trimester recorded the highest frequency in malaria infections generally. This result pattern has shown that pregnant women of blood group O were most affected by malaria parasites during the first trimester and later dropped slightly in the second and third trimester probably due to commencement of treatment. This finding may probably be attributed to the fact that blood group O lacks of antigens A and B. The observed decrease in the parasite density with the increase in parity may probably be attributed to malaria treatments during the ante-natal periods. Pregnant women aged 31 to 35 years (Table 4) recorded the highest frequency of malaria infection in the study. This might probably be due to the high occurrence of this age group in the study. Also the immune system of the older pregnant women may be weaker than the younger ones, hence affecting the older ones more [20]. The observed high parasite density in the first trimester of group O pregnant women (Table 5) might be due to exposure to mosquito bites and non-treatment of malaria due to high risk to the foetus at the early stage of pregnancy [21]. The malaria drugs may likely affect the foetus at the early stage of development in pregnancy [22].

Previous researchers stated that people of blood group A and B are more susceptible to malaria infection than people of blood group O. However, the infection differs as a result of differential host susceptibility [23]. Possible explanation for higher prevalence of malaria infection, could be that there are no blood group antigens on the surface of O group red cells, and hence more number of receptors and chances of attachment of malarial parasites, where in blood group A, B and AB, the red cells are covered with respective blood group antigens and there is less number of receptor for malarial parasites and less chances for attachment of malaria parasite to these red cells [24].

In conclusion, the study demonstrated high malaria parasite density in pregnant women of blood groups AB+ and O+ of first and second trimester. Since group AB has both A and B antigens but lacks the preformed antibodies, and group O has both anti-A and anti-B antibodies but lacks the A and B antigens, these findings may suggest that ABO blood group has no influence on malaria parasites in pregnancy rather the findings may be due to the occurrence of different ABO blood groups in pregnancy with malaria parasite infection.

Table 5. Mean ± standard deviation of malaria parasite density (MP/Microliter) of the different trimesters and different ABO blood groups.

Blood group	First trimester	Second trimester	Third trimester	Non-pregnant control
Group A	8.0 ± 2 (P 0.015)*	5.2 ± 1.3 (P 0.017)*	3.2 ± 1.1 (P 0.216)	2.0 ± 1.0
Group B	3.4 ± 1 (P 0.054)	4.0 ± 1 (P 0.027)*	3.2 ± 1.1 (P 0.070)	1.2 ± 0.9
Group AB	6.2 ± 2 (P 0.010)*	11.2 ± 2 (P 0.0045)*	6.0 ± 0.8 (P 0.012)*	2.4 ± 1.3
Group O	20.6 ± 4 (P 0.0075)*	10.8 ± 2 (P 0.008)*	4.4 ± 1 (P 0.0285)*	2.0 ± 0.4

*(Significant increase when compared with the control)

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None

Conflict of Interest

We have no conflict of interest to disclose.

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