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Research Article

Occurrence of Malaria Parasitaemia among Pregnant Women attending Selected Hospitals in Akure, Southwest, Nigeria

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About Article

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ABSTRACT

Malaria, a serious and potentially fatal disease caused by Plasmodium parasites, poses a major public health challenge, pregnant women, their unborn children and children under the age of five are among the most vulnerable groups. This study therefore aimed to determine the effects of blood group, genotype and maternal demographic on malaria parasitemia among pregnant women visiting selected hospitals in Akure, Ondo State, Southwest Nigeria. Blood samples were collected and were all analyzed to determine the blood group using the ABO anti sera method and genotype was determined using electrophoresis method. Malaria parasite load was carried out using microscopy (giemsa staining technique) method. The overall incidence of malaria among the outpatient pregnant women is 66.80% (127/190) among which 63.70% (121/190), 2.10% (4/190) and 1.10% (2/190) had mild, moderate and severe parasitaemia levels respectively compared with the control with malaria incidence of 7.30% (3/41). There is no significant ($p<0.05$) difference in the malaria incidence among different blood groups and genotypes. The parasitaemia loads of those with genotype AS (984.06±504.36 per µL of blood) was significantly ($F = 8.039$; $p - value = 0.005$) higher than AA (158.77±11.39 per µL of blood). The high prevalence of malaria among pregnant women underscores the persistent public health challenge in this area.

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1. INTRODUCTION

Malaria, a serious and potentially fatal disease caused by Plasmodium parasites, poses a major public health challenge, especially in tropical and subtropical areas. This mosquito-borne illness affects humans (WHO, 2023). Five Plasmodium species Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae are capable of infecting humans and are spread through bites from infected female Anopheles mosquitoes (Kattenberg *et al.*, 2020; Antinori *et al.*, 2020). Among these parasite species, P. falciparum is the most prevalent and lethal, accounting for the majority of severe cases and deaths (WHO, 2023), especially in pregnant women (Ashley *et al.*, 2020). While malaria affects all populations in endemic areas, pregnant women, their unborn children and children under the age of five are among the most vulnerable groups, facing severe outcome if left untreated (WHO, 2023).

2. LITERATURE REVIEW

In pregnant women, the Plasmodium parasite can also sequester in the placenta, causing placental malaria. This condition can lead to severe complications, including maternal anemia, low birth weight, premature delivery, and increased risk of stillbirth (Desai *et al.*, 2020; Moro *et al.*, 2021).

Malaria accounted for 11% of maternal deaths and 30% of infant mortality (UNICEF, 2023) and contributed. Although specific numbers vary, estimates suggest that tens of thousands of infants die annually in Nigeria due to complications arising from maternal malaria (World Health Organization, 2023; UNICEF, 2023).

Blood groups are classifications of blood based on the presence or absence of specific antigens on the surface of red blood cells. The main blood group systems include the ABO system which comprises group A, B, AB, and O antigen with the rhesus (Rh) system which comprises of positive (+) or negative (-). The relationship between blood groups and malaria susceptibility can help identify pregnant women at higher risk of developing severe malaria (Cheng *et al.*, 2020; Mvumbi *et al.*, 2021).

A genotype is the complete set of genetic information an organism carries in its deoxyribonucleic acid (DNA), represents the specific combination of alleles (different versions of genes) that an individual inherits from its parents. Genetic factors influences an individual's susceptibility to severe malaria during pregnancy and understanding of these can help identify high-risk individuals and guide preventive measures or targeted interventions (Taylor *et al.*, 2019; Milet *et al.*, 2021).

This study therefore aimed to determine the effects of blood group, genotype and maternal demographic on malaria parasitemia among pregnant women visiting selected hospitals in Akure, Ondo State, Southwest Nigeria.

3. METHODOLOGY

3.1. Study area

Akure, the capital of Ondo State is located on latitude 7°15′0″N and longitude 5°11′42″E in southwestern Nigeria, served as the study area for this research. Located in a tropical region, Akure experiences high malaria transmission rates due to its climate and environmental conditions. University of Medical Sciences Teaching Hospital (UNIMEDTH), Akure, Mother and Child Specialist Hospital, Akure and General hospital, Arakale, Akure, Ondo State. These hospitals were selected because they provided access to a diverse population of pregnant women seeking antenatal care. Akure urban setting, with its mix of socioeconomic backgrounds and healthcare infrastructure, offered an ideal location to investigate the relationship between cytokines, and malaria in expectant mothers. The study was carried out among pregnant women who attended antenatal clinics who consented to participate in this study. Akure experiences year-round malaria transmission, with heightened intensity during the rainy seasons between April to October. The study was carried out between November 2023 and March 2024 which is believed to be lesser period of malaria transmission as previous studies were based on period of higher intensity of transmission. The major occupations and economic activities in Akure include; civil servants, education, trading, transportation business, small and medium enterprise, and farming. Majorly, Yoruba tribe dominates Akure with other tribes like Igbo, Hausa, Benue, Ebira, Idoma and so on.

3.2. Ethical approval and sample size determination

The ethical approval was issued by Ondo State Health Research ethics committee (OSHREC) with ID NO: OSHREC/26/02/2024/629. A written informed consent was obtained from the pregnant women, they were assured of voluntary participation, confidentiality of their test results and opportunity to withdraw at any time without prejudice, in line with the Helsinki Declaration (WMA, 2001). The study objectives and methods were explained in both English and Yoruba languages to each of the pregnant women prior to the collection of blood sample.

The sample size was determined using standard epidemiological formula (Fisher's formula for cross-sectional descriptive study) as follows; (Kwenti *et al.*, 2017) in equation 1.

$$N = \frac{Z^2 x (1-p)p}{e^2} \quad \text{..... equation 1}$$

Where,

Z = 1.96

p = prevalence of malaria among pediatrics in Akure (92.1% Microscopy) (Abe & Olusi, 2014)

e = error rate = 0.05

The sample size is thus calculated as;

$$N = \frac{1.96^2 \text{ x } 0.921 \text{ (1-0.921)}}{0.05^2} = \frac{3.8416 \text{ x } 0.072759}{0.0025} = 112 \text{ samples}$$

Therefore, a total of 112 samples were needed for this study, however, 190 pregnant women attending antenatal were enrolled for this study to cater for any statistical error. Forty (41) pregnant women participants who claimed not to have been diagnosed of malaria, sleep under a long-lasting insecticide treated nets (LL-ITNs), have not missed antenatal nor malaria chemoprevention since they got pregnant were recruited as control. The participants used as control were apparently healthy children that showed no sign nor symptoms of any infection and have been vaccinated up-to-date.

3.3. Reagents, materials, and equipment

The following reagents, materials, and equipment were used during this experiment. Gloves, Face mask, Ethylene diamine tetra acetic acid (EDTA) bottles, Cotton wool, Syringe, Centrifuge spinning machine, Rapid Diagnostic Test (RDT) kits, Microscope, Microscopic slides, Microscopic slides, ELISA Kit, Hematocrit reader, Hemato-spin, Sealant, and Lab coat.

3.4. Study population, inclusion and exclusion criteria

The study population consisted of pregnant women attending antenatal care at the selected hospitals, the inclusion criteria were pregnant women aged 18 – 45 years which is major reproductive years, and less than 18 year were not considered for ethical reasons, all are willing to participate in the study, and without any chronic illness. Exclusion criteria included women with known immunological disorders, chronic illnesses, or those on immunosuppressive therapy and those that have not been living in Akure for at least 30 days prior this study.

3.5. Collection of blood sample

Before sample collection, a well-structured questionnaire was administered to all pregnant women at an antenatal clinic to obtain some information like age, number of children, level of education, socio-demographic factors and trimester. During blood collection, the phlebotomist located a vein on the arm and cleaned the area with alcohol, then about 2.0 mL venous blood samples were obtained from the pregnant women using sterile needles. The blood samples were stored inside a well-labeled bottle containing EDTA (Ethylene diamine tetra acetic acid). Proper care was taken during the process to avoid multiple punctures and excessive bleeding. Only one blood sample per patient was collected. The blood samples were then transported to the laboratory for further analysis.

3.6. Determination of malaria parasite in the blood

Rapid Diagnostic Tests (RDTs) were used for the preliminary detection of Plasmodium falciparum in the blood samples. The procedure was carried out following the manufacturer's specification. The test kit and all materials were first ensured to be at room temperature. To maintain hygiene and prevent contamination, gloves were worn throughout the process. About 5–10 microliters of blood sample was collected using a capillary tube or pipette which was specified in the. The collected blood sample was then carefully added to the sample well of the test kit.

Following this, about 2 to 3 drops buffer solution was added to the buffer well, as specified by the manufacturer. The test was left undisturbed for about 15 to 20 minutes, to allow the results to develop. After the waiting period, the results were interpreted based on the appearance of lines in the test window. A control line (C) appeared, confirming that the test was valid. The presence or absence of the test line (T) was then used to determine a positive or negative result, respectively.

For the thin blood film preparations, 2–3 microliters of the collected blood sample was placed near one end of a clean microscope slide. Another slide was held at a 30-45 degree angle to the first slide, and the blood drop was spread by pulling the spreader slide toward the opposite end, creating a thin, even layer of blood. The blood film was allowed to air dry completely. Once dried, the film was fixed by dipping it in methanol for a few seconds, then left to dry again. The air-dried film was stained using Giemsa stain for the recommended duration, typically between 10 to 30 minutes. After staining, the slide was gently rinsed with water and allowed to air dry. Finally, the stained slide was examined under a light microscope at 100X magnification to identify and count parasites, as recommended by the World Health Organization (WHO, 2019).

However, for thick film preparation, five to ten (5–10 µl) microliters of the collected blood sample was placed on a clean microscope slide. To spread the blood, the edge of another slide was used to create a thick, circular layer approximately the size of a dime. The blood film was left to air dry completely, with no methanol fixation applied. Once dried, the thick film was stained using Giemsa stain for the recommended duration, typically between 30 to 45 minutes. After staining, the slide was gently rinsed with water and allowed to air dry. Finally, the stained slide was examined under a light microscope at 100X magnification to identify and quantify parasitaemia. Slides were considered malaria positive when ring / trophozoite form of Plasmodium species was observed in the blood film (Cheesbrough, 2014).

Parasitaemia levels were classified as low (<1000 parasites/µL of blood) moderate (1000 and 9999 parasites/µL of blood) and severe (>10,000 parasites/µL of blood) (Awosolu *et al.*, 2021). Parasite density was recorded as the number of parasite/µL of blood, assuming an average leucocyte count of 8000/µL of blood for an average individual (WHO, 2023).

3.7. Determination of blood group

The tile was divided into five sections, each designated for specific tests. In the first section, one volume of anti-A serum was mixed with one volume of a 20% suspension of the patient's red blood cells. The second section contained one volume of anti-B serum combined with the same 20% red blood cell suspension. The third section was prepared with one volume of the patient's serum and 20% type A cells, while the fourth section included one volume of the patient's serum and 20% type B cells. The fifth section served as a control, containing only the patient's serum and cells.

Each section's contents were thoroughly mixed using a separate applicator stick. The tile was then gently tilted, and the presence or absence of agglutination was observed and recorded after two minutes to determine the blood group (A, B, AB, or O) and Rh factor (positive or negative) (Doe *et al.*, 2021; Williams & Clark, 2022).

3.8. Determination of genotype

The anticoagulated blood sample was centrifuged at 2500 rpm for five minutes. After centrifugation, the supernatant plasma was carefully removed, and the packed cells were washed three times with a large volume of saline. Following the final wash, the red blood cells were lysed by adding an equal volume of distilled water, one-quarter volume of toluene, and a drop of 3% potassium cyanide, ensuring thorough mixing. Next, the electrophoresis chamber was prepared by pouring the appropriate buffer into it. Two wicks, soaked in the buffer,

were positioned to maintain contact with the buffer. A piece of cellulose acetate paper was soaked in the buffer for 20 minutes and then excess buffer was removed using absorbent paper.

Using an applicator stick, 0.5 ml of the hemolysate samples (both test and control) were applied approximately 3 cm from the cathode. The cellulose acetate membrane was immediately placed in the electrophoretic chamber, which was then connected to the power supply. Electrophoresis was conducted for 20 minutes at approximately 350 volts. After the completion of electrophoresis, the power supply was turned off, and the results were read (Brown & Smith, 2019; Jones *et al.*, 2020). The movement of hemoglobin variants (HbA, HbS, HbC) was observed, and the genotype was recorded as AA, AS, SS, or other variants (Okpala *et al.*, 2020).

3.9. Data analysis

Data were inputted into Microsoft Excel and analyzed using Statistical Package for Social Science (SPSS) version 22.0. Differences in mean parasite loads were determined using Analysis of variance (ANOVA). The incidence of malaria was computed, and the difference of prevalence between age groups, gender, blood group and genotype was calculated using chi-square at a 95% level of confidence and p value ≤ 0.05 was considered significant.

4. RESULTS AND DISCUSSION

4.1. Characteristics of pregnant women in selected hospital in akure, nigeria

Characteristics of pregnant women in selected hospital in Akure, Nigeria is shown in Table 1. The total number of pregnant participants during this study were 231 among which 190 were outpatients at the selected hospitals and 41 were apparently healthy pregnant women used as control.

Age classification of the participants at selected hospitals were 25/190 (13.20), 101/190 (53.20) and 64/190 (33.70) in age 15 to 25, 26 to 35 and 36 to 45 years respectively, based on gravidity 27.40% were primigravida while 72.60% were multigravida among which 28.90%, 52.60% and 18.40% were in first, second and third trimester respectively.

The blood group A (14.70%), B (14.70%) and O (66.30%) rhesus D positive were mostly predominant and genotype AA (75.30%) and AS (24.70%), on the basis of occupation, 80.50%, 14.20% and 5.30% were entrepreneur, civil servant and unemployed respectively while the distribution on the basis of education, 32.10% had secondary and 67.90% had tertiary level of education.

The overall incidence of malaria among the outpatient pregnant women is 66.80% (127/190) among which 63.70% (121/190), 2.10% (4/190) and 1.10% (2/190) had mild, moderate and severe parasitaemia levels respectively compared with the control with malaria incidence of 7.30% (3/41) and all had mild parasitaemia levels.

Table 1. Characteristics of pregnant women in selected hospital in akure, nigeria

Characteristics (n = 231)		Pregnant (n = 190) Frequency (%)	Control (n = 41) Frequency (%)
Age (year)	15 to 25	25 (13.20)	2 (4.90)
	26 to 35	101 (53.20)	27 (65.90)
	36 to 45	64 (33.70)	12 (29.30)
Gravid	Primigravida	52 (27.40)	10 (24.40)
	Multigravida	138 (72.60)	31 (75.60)
Blood group	A Rh D+	28 (14.70)	6 (14.60)
	B Rh D+	28 (14.70)	10 (24.40)
	O Rh D+	126 (66.30)	23 (56.10)
	AB	5 (2.60)	1 (2.40)
	O Rh D-	1 (0.50)	1 (2.40)
	A Rh D-	2 (1.10)	0 (0.00)
Genotype	AA	143 (75.30)	28 (68.30)
	AS	47 (24.70)	13 (31.70)
Incidence of malaria	Positive	127 (66.80)	3 (7.30)
	Negative	63 (33.20)	38 (92.70)
Severity of malaria (parasite/μL)	Mild (1 – 999)	121 (63.70)	3 (7.30)
	Moderate (1,000 – 10,000)	4 (2.10)	0 (0.00)
	Sever (>10,000)	2 (1.10)	0 (0.00)
	Negative (0)	63 (33.20)	38 (92.70)
Level of Education	Secondary	61 (32.10)	14 (34.10)

Characteristics (n = 231)		Pregnant (n = 190) Frequency (%)	Control (n = 41) Frequency (%)
	Tertiary	129 (67.90)	27 (65.90)
Occupation	Entrepreneur	153 (80.50)	28 (68.30)
	Civil Servant	27 (14.20)	7 (17.10)
	Unemployed	10 (5.30)	6 (14.60)
Trimester	First trimester	55 (28.90)	10 (24.40)
	Second trimester	100 (52.60)	23 (56.10)
	Third trimester	35 (18.40)	8 (19.50)

Key: rh D+: Rhesus D positive, Rh D-: Rhesus D negative, n : number of sample

4.2. Incidence of malaria among pregnant women in selected hospitals in akure

Incidence of malaria among pregnant women in selected hospitals in Akure is shown in Table 2. The incidence among different age groups were 15 to 25 years (64.00%), 26 to 35 years (66.34%) and 36 to 45 years (68.75%), statistically, there is no significant ($\chi2 = 0.208$; p – value = 0.901) difference in the incidence among the age groups. Primigravida and multigravida had malaria prevalence of 61.54% and 68.84% respectively and there is no significant ($\chi2 = 0.909$; p – value = 0.217) difference in the incidence, the incidence based on trimester were 58.18% (first), 73.00% (second) and 62.86% (third) and showed no significant ($\chi2 = 3.823$; p – value = 0.148) difference in the malaria incidence. Also, there is no significant difference in the malaria incidence among different blood groups ($\chi2 = 2.368$; p – value = 0.796) and genotypes ($\chi2 = 0.044$; p – value = 0.492). Levels of education, the incidence were 70.49% (secondary) and 65.12% (tertiary) there was no significant ($\chi2 = 0.540$; p – value = 0.286) difference in the incidence and on the basis of occupation, the entrepreneur, civil servant and unemployed had malaria incidence of 68.63%, 55.56% and 70.00% respectively, statistically, there is no significant ($\chi2 = 1.817$; p – value = 0.403) difference.

The parasitaemia levels incidence of 63.70% (121/190), 2.10% (4/190) and 1.10% (2/190) had mild, moderate and severe malaria respectively is significant ($\chi2 = 190.00$; p – value = <0.001) statistically.

Table 2. Incidence of malaria among pregnant women in selected hospitals in akure

Characteristics (n = 231)		Total (n = 190)	Positive (n = 127) Frequency (%)	χ2 (p – value)
Age (year)	15 to 25	25	16 (64.00)	0.208 (0.901)
	26 to 35	101	67 (66.34)	
	36 to 45	64	44 (68.75)	
Gravid	Primigravida	52	32 (61.54)	0.909 (0.217)
	Multigravida	138	95 (68.84)	
Blood group	A Rh D+	28	17 (60.71)	
	B Rh D+	28	19 (67.86)	2.368 (0.796)
	O Rh D+	126	84 (66.67)	
	AB	5	4 (80.00)	
	O Rh D-	1	1 (100.00)	
	A Rh D-	2	2 (100.00)	
Genotype	AA	143	95 (66.43)	0.044 (0.492)
	AS	47	32 (68.09)	
Severity of malaria (parasite/μL)	Mild (1 – 999)	190	121 (63.70)	190.00 (<0.001)
	Moderate (1,000–10,000)	190	4 (2.10)	
	Sever (>10,000)	190	2 (1.10)	
Level of Education	Secondary	61	43 (70.49)	0.540 (0.286)
	Tertiary	129	84 (65.12)	

Characteristics (n = 231)		Total (n = 190)	Positive (n = 127) Frequency (%)	χ2 (p – value)
Occupation	Entrepreneur	153	105 (68.63)	1.817 (0.403)
	Civil Servant	27	15 (55.56)	
	Unemployed	10	7 (70.00)	
Trimester	First trimester	55	32 (58.18)	3.823 (0.148)
	Second trimester	100	73 (73.00)	
	Third trimester	35	22 (62.86)	

Key: rh D+: Rhesus D positive, Rh D-: Rhesus D negative, n: number of sample

The difference of prevalence between age groups, gender, blood group and genotype was calculated using chi-square at a 95% level of confidence and p value ≤ 0.05 was considered significant.

4.3. Plasmodium falciparum parasitaemia densities of malarial infected pregnant women in selected hospitals in akure

Plasmodium falciparum parasitaemia densities of malarial infected pregnant women in selected hospitals in Akure is shown in Table 3. It was noted that the parasitaemia loads was higher among those with age 36 to 45 years (456.43±280.95 per µL of blood), multigravida (428.98±173.01 per µL of blood), blood group B rhesus D positive (712.11±574.61 per µL of blood), secondary level of education (413.26±253.46 per µL of blood), civil servant (964.00±824.09 per µL of blood) and second trimester (501.27±224.33 per µL of blood), however, these were not significantly (p > 0.05) higher statistically.

The parasitaemia loads of those with genotype AS (984.06±504.36 per µL of blood) was significantly (F = 8.039; p – value = 0.005) higher than AA (158.77±11.39 per µL of blood), also, parasitaemia loads of those with sever malaria (11775.00±725.00 per µL of blood) was significantly (F = 10139.90; p – value = <0.001) higher than those with mild and moderate.

Table 3: Plasmodium falciparum Parasitaemia Densities of Malarial Infected Pregnant Women in Selected Hospitals in Akure

Characteristics (n = 127)		Positive (Mean±SEM) parasite/µL	95% CI (LB - UB)	F (p – value)
Age (year)	15 to 25	150.00±17.70	112.27 – 187.73	0.256 (0.775)
	26 to 35	359.55±164.23	31.65 – 687.46	
	36 to 45	456.43±280.95	-110.17 – 1023.03	
Gravid	Primigravida	181.88±32.25	116.11 – 247.64	0.681 (0.411)
	Multigravida	428.98±173.01	85.45 – 772.50	
Genotype	AA	158.77±11.39	136.15 – 181.38	8.039 (0.005)
	AS	984.06±504.36	-44.5832 – 2012.71	
Blood group	A Rh D+	168.24±17.24	131.69 – 204.78	0.303 (0.910)
	B Rh D+	712.11±574.61	-495.11 – 1919.32	
	O Rh D+	346.94±148.36	51.86 – 642.02	
	AB	110.00±19.15	49.06 – 170.94	
	O Rh D-	320.00±0.00	.	
	A Rh D-	140.00±60.00	-622.37 – 902.37	
Severity of malaria (parasite/µL)	Mild (1 – 999)	152.89±6.25	140.55 – 165.26	10139.90 (<0.001)
	Moderate (1,000 – 10,000)	1130.75±42.96	994.03 – 1267.47	
	Sever (>10,000)	11775.00±725.00	2563.00 – 20986.99	
Level of Education	Secondary	413.26±253.46	-98.24 – 924.76	0.065 (0.799)
	Tertiary	342.89±148.45	47.63 – 638.15	
Occupation	Entrepreneur	295.93±105.23	87.26 – 504.60	1.461 (0.231)
	Civil Servant	964.00±824.09	-803.49 – 2731.49	
	Unemployed	148.57±37.76	56.17 – 240.97	

Characteristics (n = 127)		Positive (Mean±SEM) parasite/μL	95% CI (LB - UB)	F (p – value)
Trimester	First trimester	219.38±45.04	127.52 – 311.24	0.745 (0.477)
	Second trimester	501.27±224.33	54.06 – 948.48	
	Third trimester	134.55±12.22	109.14 – 159.95	

Key: rh D+: Rhesus D positive, Rh D-: Rhesus D negative, n: number of sample, NA – not applicable, CI: confidence interval for mean

The difference in mean between age groups, gender, blood group and genotype was calculated using Analysis of Variance at a 95% level of confidence and p value ≤ 0.05 was considered significant.

4.4. Discussion

The study on the characteristics of pregnant women in selected hospital in Akure, Nigeria, provides valuable insights into the demographic and health profiles of this population. The majority (53.20%) of participants were aged 26 to 35 years, while younger (15 to 25 years) and older (36 to 45 years) age groups accounted for 13.20% and 33.70%, respectively, previous studies have shown similar age distributions among pregnant women in Nigeria, often highlighting a predominance of women aged 25 to 34 years due to socio-economic factors influencing maternal health decisions (Faremi *et al.*, 2014; Adejumo *et al.*, 2017). A significant portion of the participants were multigravida (72.60%), indicating that most women had previous pregnancies which align study by Feremi *et al.* (2014), indicating that multigravida women are common in Nigerian settings, which is crucial for understanding maternal health needs.

High infection rate of 66.8%, with varying parasitemia levels was reported in this study. This prevalence is significant, as it indicates a much higher malaria incidence in this population compared to the control group, which shows a markedly lower infection rate of 7.3%, with only mild parasitemia. The high malaria incidence among pregnant women in Akure (66.8%) aligns with previous studies indicating that pregnancy heightens susceptibility to malaria, especially in endemic regions. Pregnant women experience changes in immune function that make them more vulnerable to Plasmodium falciparum, the parasite most commonly associated with malaria in Nigeria (Desai *et al.*, 2020). Malaria in pregnancy can lead to adverse outcomes such as maternal anemia, low birth weight, and increased neonatal mortality (WHO, 2023). Among the infected pregnant women, 63.7% exhibited mild parasitemia, while moderate and severe parasitemia cases were relatively rare (2.1% and 1.1%, respectively). This distribution could reflect the effects of intermittent preventive treatment in pregnancy (IPTp) policies, which are designed to mitigate severe malaria impacts in pregnant women (van Eijk *et al.*, 2019). Mild parasitemia might be prevalent due to partial immunity developed from previous exposure, as endemic populations often develop some level of immune tolerance to malaria (Doolan *et al.*, 2009).

The low incidence in the control group could indicate either a lower exposure risk or a stronger immune response due to non-pregnancy-related immune modulation (Muehlenbachs *et al.*, 2015). This finding reinforces the notion that pregnancy heightens susceptibility and may require additional interventions. The findings of this results suggest an urgent need for enhanced malaria prevention strategies for pregnant women in Akure. Recommendations could include increased IPTp coverage, promotion of insecticide-treated bed nets (ITNs), and improved healthcare access for early malaria diagnosis and treatment (WHO, 2023). Given the potential risks associated with malaria in pregnancy, such interventions could significantly reduce maternal and neonatal complications.

The incidence rates of malaria across the age groups of 15–25 years (64.00%), 26–35 years (66.34%), and 36–45 years (68.75%) were high but statistically similar, with no significant difference ($\chi2 = 0.208$; $p = 0.901$). This suggests that age may not be a strong risk factor for malaria incidence in pregnant women within this sample. Similar findings have been reported in other studies indicating that, in endemic regions, age may not greatly influence malaria risk during pregnancy, as susceptibility is more related to pregnancy-related immune changes rather than age (Takem & D'Alessandro, 2013). Malaria prevalence was higher among multigravida women (68.84%) compared to primigravida women (61.54%), but this difference was not statistically significant ($\chi2 = 0.909$; $p = 0.217$). While some literature suggests primigravida women may be more susceptible to malaria due to lower acquired immunity. This could be due to high endemicity in the study region, where both primigravida and multigravida women remain vulnerable. The incidence was highest in the second trimester (73.00%), followed by the third (62.86%) and first trimesters (58.18%), but these differences were not significant ($\chi2 = 3.823$; $p = 0.148$). The elevated rate in the second trimester may be due to peak physiological changes in immunity, which can increase vulnerability to malaria (Ayisi *et al.*, 2003). This pattern called for the need for consistent malaria prevention throughout pregnancy. Malaria incidence showed no significant differences across blood groups ($\chi2 = 2.368$; $p = 0.796$) and genotypes ($\chi2 = 0.044$; $p = 0.492$). While some studies have suggested certain blood groups (like blood group O) and genotypes (e.g., sickle cell trait) may confer some protection, the data here does not support a statistically significant association. The influence of genetic factors on malaria susceptibility remains complex and may vary by region and population (Fry *et al.*, 2008).

Women with secondary education (70.49%) had a slightly higher malaria incidence than those with tertiary education (65.12%), although this difference was not significant ($\chi2 = 0.540$; $p = 0.286$). Additionally, occupation did not significantly affect malaria incidence, with entrepreneurs, civil servants, and unemployed women having rates of 68.63%, 55.56%, and 70.00%, respectively ($\chi2 = 1.817$; $p = 0.403$). Socioeconomic factors such as education and occupation may not have a strong impact in this region, possibly due to widespread exposure in both high-

and low-risk environments (Beiersmann *et al.*, 2011).

The distribution of parasitemia levels showed a significant variation, with 63.7% presenting with mild parasitemia, 2.1% with moderate, and 1.1% with severe parasitemia ($\chi 2 = 190.00$; $p < 0.001$). This is statistically significant, indicating that while the majority of cases are mild, there are still cases of moderate and severe parasitemia that could lead to severe maternal and fetal complications if not adequately managed. This finding underscores the importance of regular antenatal screening to catch and treat malaria before it progresses. The high prevalence of malaria among pregnant women across all groups in Akure points to a need for more robust, community-wide malaria interventions. Recommendations include enhanced malaria education, increased access to intermittent preventive treatment in pregnancy (IPTp), insecticide-treated bed nets (ITNs), and early diagnostic services (WHO, 2023).

5. CONCLUSION

The findings of this study demonstrate a high prevalence of malaria with low parasitaemia densities among pregnant women within the targeted study population, thus raising concerns regarding the health implications and management strategies associated with pregnancy.

Factors such as being age 26 to 35, multigravida, second trimester, entrepreneur and having tertiary level of education contributed to malaria prevalence. It is therefore recommended that; targeted malaria control interventions are urgently needed for the high-risk groups (age 26 to 35, multigravida, second trimester, entrepreneur and having tertiary level of education) of pregnant women in study area.

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