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ASSESSING THE EFFECT OF PLACENTAL MALARIA ON NEONATAL BIRTH WEIGHTS IN UYO, NIGERIA

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ABSTRACT

Placental malaria (PM), caused by sequestration of Plasmodium falciparum-infected red blood cells in the placenta, disrupts nutrient and oxygen transfer to the fetus. It is strongly linked to low birthweight, intrauterine growth restriction, and increased neonatal mortality in malaria-endemic areas. This study assessed the prevalence of PM and its effect on birth weight among pregnant women in Uyo, Nigeria. A descriptive cross-sectional study was conducted among 405 pregnant women attending antenatal clinics in four health facilities, each from a different community in Uyo LGA. Data were collected using a structured interviewer-administered questionnaire. Venous blood samples were taken during pregnancy, and placental blood was collected after delivery. Data analysis was performed using SPSS version 25, with statistical significance set at $p < 0.05$. Respondents' ages ranged from 16 to 46 years, with most aged 26–30 years. Malaria parasite prevalence was 25.9% (105/405). Prevalence was highest among women aged 16–20 years (80%) and lowest in those aged 41–46 years (14.2%), a statistically significant difference ($p = 0.001$). Malaria prevalence varied by trimester ($p = 0.002$), peaking in the first trimester (47.5%). Of the 106 women who delivered during the study, 18 (16.9%) had placental malaria. Newborns of malaria-positive mothers had lower birth weights (1.5–2.9 kg) compared to those of malaria-negative mothers (3.0–4.4 kg). The findings highlight a strong association between placental malaria especially early in pregnancy and low birth weight. Early diagnosis and intermittent preventive treatment are essential to reduce placental malaria and improve neonatal outcomes in endemic regions.

Keywords: Placental malaria, Birthweight, Pregnancy, Intermittent Preventive Treatment, Sulphadoxine Pyrimethamine, Uyo

INTRODUCTION

Malaria remains a major global health issue, with 249 million cases and 608,000 deaths reported in 2022 (WHO, 2024). Pregnant women are highly vulnerable due to immune and physiological changes, which increase the risk of severe outcomes such as maternal anemia, stillbirth, intrauterine growth restriction (IUGR), low birth weight (LBW), and neonatal death (WHO, 2024; Minwuyelet *et al*., 2025). Placental malaria (PM), a severe form of malaria in pregnancy, occurs when *Plasmodium*-infected red blood cells accumulate in the placenta, disrupting its structure and function. This leads to impaired nutrient and oxygen exchange, triggering inflammation and resulting in complications such as LBW, IUGR, preterm delivery, and increased perinatal mortality (Oranuka *et al*., 2024; Cardona and Carmona, 2024), and accounts for over 100,000 infant deaths annually in endemic region (WHO, 2024).

Nigeria, which accounts for 27% of the global malaria burden, faces significant PM-related maternal and neonatal health challenges. Only 42% of pregnant women in rural areas complete the WHO-recommended Intermittent Preventive Treatment in pregnancy with Sulfadoxine-Pyrimethamine (IPTp-SP) doses (NMIS, 2022). Placental malaria remains underreported, with hospital-based studies showing prevalence rates between 14% and 40% (Okeke *et al*., 2024; Omidiji *et al.,* 2025). Placental malaria-associated LBW contributes to Nigeria's neonatal high mortality rate of 35 per 1,000 live births (UNICEF, 2024). The South-South region of Nigeria, including Uyo in Akwa Ibom State, faces high malaria transmission due to its humid, rainy climate (NDHS, 2019). Despite high awareness, only 47.5% of pregnant women in Uyo completed the full IPTp-SP doses, with MiP prevalence at 22.3% (Akpan *et al.,* 2021, 2023). Archibong *et al.* (2023) observed immune disturbances in asymptomatic cases, indicating risk of adverse outcomes. In Eket, Udofia (2025) reported a 29.1% MiP rate, with over 35% not seeking formal healthcare.

Although national guidelines emphasise malaria prevention in pregnancy, routine placental examinations are rarely conducted in Nigeria, resulting in underdiagnosis and underreporting of PM (Oranuka *et al*., 2024). This has led to a critical evidence gap, particularly in high-burden areas like Uyo, where clinicians frequently observe LBW deliveries among malaria-exposed pregnancies. Despite global advances in malaria control, PM remains a serious threat to neonatal health in high-burden settings. This study, therefore, investigated the impact of placental malaria on birthweight outcomes among newborns in Uyo, Akwa Ibom State.

MATERIALS AND METHODS

Study Area

This study was conducted in Uyo, the capital of Akwa Ibom State, located in the South-South region of Nigeria. Geographically, Uyo lies at latitude 5°02′20.27″ N and longitude 7°54′34.09″ E. According to the National Population Census, the city had a population of 429,900 (NPC, 2006). Uyo is situated within the equatorial rainforest belt and experiences a tropical climate, characterized by a distinct wet season (April to October) and dry season (November to March). Average temperatures range from 23°C in July to 31°C between January and May, while relative humidity fluctuates between 69% in January and 98% in July.

The population of Uyo is diverse, comprising farmers, fisherfolk, civil servants, traders, and students. The city is well served by a range of healthcare facilities that offer antenatal care services.(Britannica, 2024). Prominent among these are the University of Uyo Teaching Hospital, St. Luke's Hospital Anua, and the Primary Health Centres at Ikono and Oku.

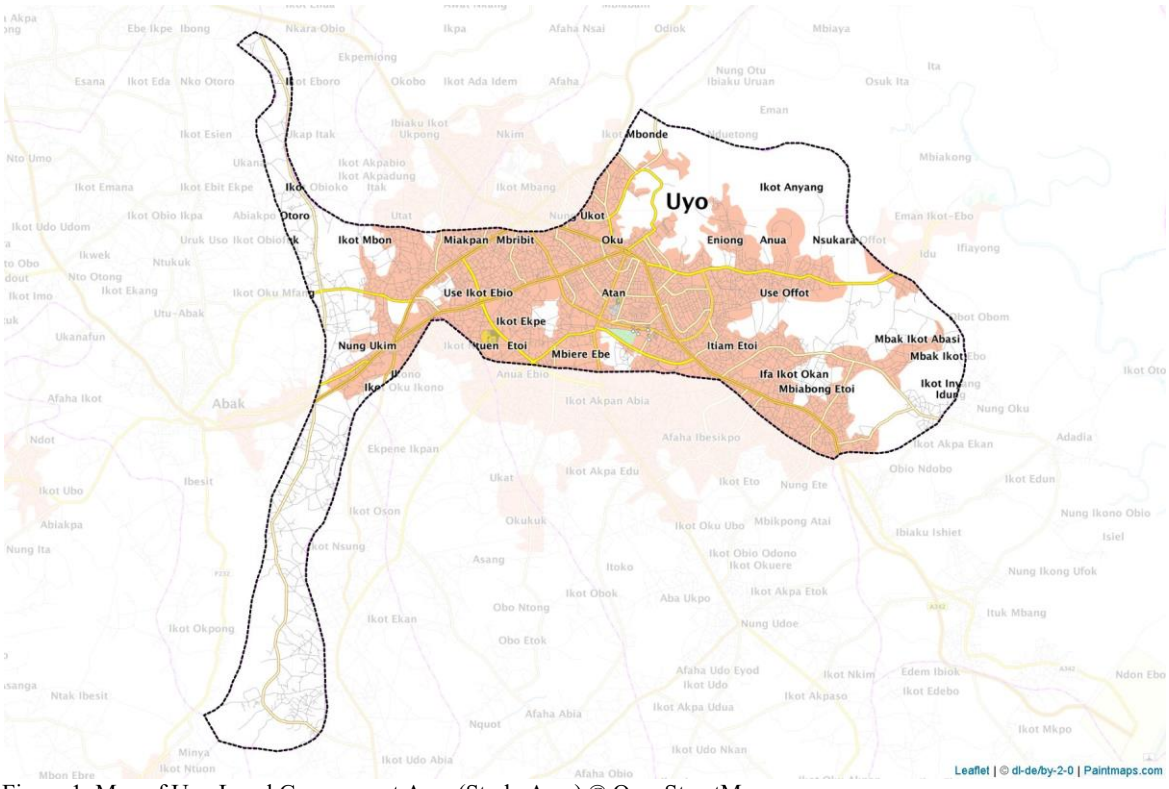

Figure 1: Map of Uyo Local Government Area (Study Area) © OpenStreetMap

Study Population

Pregnant women who attended antenatal care and those who delivered their babies during the study period, between November 2018 - May 2019, in four selected healthcare facilities, one from each of the four communities in Uyo LGA. (St. Luke's hospital Anua, Primary Health Care Center Ikono, Primary Health Care Center Oku, and Dan-Abia Specialist Hospital Etoi. This was done to assess the potential impact of placental malaria infection on neonatal outcomes, particularly birthweight. Newborns were not independently enrolled but were included as dependent subjects linked to their mothers, with birthweight serving as a key outcome variable

Inclusion and Exclusion Criteria

The inclusion criteria were: (i) singleton pregnancy, (ii) willingness to provide informed consent, and (iii) availability for follow-up through to delivery. The exclusion criteria were: (i) presence of blood-borne disease known to contribute to low birthweight (e.g., maternal anaemia, sickle cell disease, HIV, hepatitis B and C, and syphilis), (ii) chronic illnesses such as diabetes and hypertension, (iii) a history of preterm labour in the current pregnancy, and (iii) multiple gestations.

Sample Size Determination

The sample size for this study was determined using Taro Yamane's formula for calculating sample size from a finite population (Yamane, 1967). The population of the study area, Uyo Local Government Area was projected from the 2006 Nigerian Population Census using an estimated annual growth rate of 3% to reflect the 2018 population. The 2006 census reported a population of approximately 309,573 for Uyo (NPC, 2006). Applying the compound growth formula:

$P_t = P_0 \times (1 + r)^t$

Where:

P_t = projected population in 2018

P_0 = population in 2006 (309,573)

r = annual growth rate (0.03 or 3%)

t = number of years from 2006 to 2018 (i.e., 12 years)

$P_{2018} = 309,573 \times (1+0.03)^{12} \approx 309,573 \times 1.42576 \approx 441,364$

Rounded, the estimated 2018 population was taken as approximately 441,400.

Based on standard demographic assumptions, approximately 25% of this population are women of reproductive age (15–49 years). (NDHS, 2019), which equals:

441,400×0.25 = 110,350 women of reproductive age

Of these, it is estimated that about 5% are pregnant at any given time, giving a target population of:

110, 350 × 0.05 = 5,517.5 ≈ 5,518 pregnant women

Using this finite population (N = 5,518), the required sample size was calculated using Taro Yamane's formula:

$n = \frac{N}{1+N\,(e)2}$

Where:

i. n = desired sample size
ii. N = population size (pregnant women = 5,518)
iii. e = margin of error (taken as 5% or 0.05)

Substituting into the formula:

$n = \frac{5518}{1+5518(0.05)2} = \frac{5518}{1+5518(0.0025)} = \frac{5518}{1+13.795} = \frac{5518}{14.795}$

≈ 373

Thus, the minimum sample size required was approximately 373 pregnant women. However, to enhance the statistical power of the study and account for potential non-response or data loss, a total of 405 pregnant women were ultimately

recruited exceeding the minimum required sample by about 9% Of these, 105 women delivered their babies during the study period and were subsequently included in the analysis of placental malaria parasitaemia and birth outcomes.

Questionnaire Design and Administration
Structured questionnaires were administered to obtain information on sociodemographic characteristic, obstetric history, use of malaria preventive measures (sulfadoxine-pyrimethamine (IPTp-SP) and long-lasting insecticidal nets (LLINs), as well as any history of fever episodes during pregnancy. In addition to self-reported data, participants' clinical records were reviewed to validate key information, particularly the number of IPTp-SP doses received and the gestational age at the time of delivery or study enrollment.

Collection of Placental Blood
After the delivery of the newborn and placenta, a puncture was made on the maternal side of the freshly delivered placenta, near the point of umbilical cord insertion, using a sterile disposable lancet. A drop of placental blood was collected onto a clean, pre-labelled glass slide with unique ID codes, and used to prepare a thick blood film for malaria parasite detection (WHO, 1991).

Collection of Peripherial Blood Samples of Pregnant Women
Peripheral blood samples were obtained using the venipuncture method using WHO guidelines. (WHO, 1991). The puncture site was disinfected with cotton wool soaked in methylated spirit, after which trained healthcare personnel performed the procedure using a new sterile 2 mL syringe. The collected blood samples were transferred into sterile Ethylenediaminetetraacetic acid (EDTA) containers. Each sample was properly labelled with the patient's data to prevent any mix-up. A total of 400 blood samples were collected.

Determination of Birthweight of Newborn Babies
The birth weights of the newborn babies were determined using a Seca 354 digital baby scale. To prevent infection during weighing, the scale was disinfected before and after use, with clean linens placed on it for each baby. The research assistants practised hand hygiene before and after contact with each newborn. Each newborn was gently placed on the scale, and the weight was recorded in kilograms as indicated on the digital display. The recorded birth weight was subsequently matched with the mother's malaria status, as determined through prior laboratory diagnosis, to assess any possible correlation between maternal malaria infection and neonatal birth weight.

Preparation of Thick Blood Films
Three drops of each blood sample were placed at the centre of a clean, grease-free microscope glass slide using a glass capillary pipette. The edge of a second slide, held at a steep angle, was used to spread the blood into small circular thick films. The films were not fixed. The slides were left to air-dry completely. Then, Giemsa stain (3% solution diluted with buffer) was applied to the thick films and allowed to stain for 30 minutes. After staining, the tap water was used to moisten the smear to haemolyse the blood cells, the slides were drained in a vertical position, and allowed to air-dry again (WHO, 1991).

Preparation of Thin Blood Films
One drop of each blood sample was placed at one end of a clean, grease-free microscope glass slide using a Pasteur pipette. A second slide was used as a spreader by placing its edge at a 45° angle to the slide containing the blood drop, allowing the blood to spread evenly along the edge. The spreader slide was then pushed smoothly across the stationary slide, drawing the blood behind it to create a thin smear. A diluted Giemsa stain (prepared for 20-minute staining) was then poured over the smear and allowed to stand for 20 minutes. After staining, the tap water was used to moisten the smear to haemolyse the blood cells, the underneath of the slide was cleaned with cotton wool, and the slide was placed on a rack to air-dry (WHO, 1991).

Microscopic Examination of Prepared Thick and Thin Blood Films
For the examination of thin and thick blood films, a drop of immersion oil was placed at the center of the thick film and at the tip (tongue) of the thin film. The slides were then examined under a microscope using the ×100 oil immersion objective lens. Each slide was systematically examined to detect malaria parasites. Species-specific morphological characteristics of human *Plasmodium* species, as outlined by WHO (2004) and Brooks *et al.* (2004), were used to identify the *Plasmodium* species present. A slide was considered positive for malaria when at least one asexual stage of *Plasmodium* was observed in 100 high-power (×100 oil immersion) microscopic fields of the thick blood film, in accordance with WHO guidelines. A slide was considered negative only after examining a minimum of 100 high-power fields without detecting any parasites.

Statistical Analysis
Data collected was screened for completeness by the researcher, coded and analysed using an electronic statistical package IBM-SPSS version 25. Univariate analysis was carried out to describe the data. Bivariate analysis was carried out using Chi-square (χ^2) test to evaluate associations and determine significant differences. The level of statistical significance was set at $p < 0.05$ at 95% confidence interval. Data were summarized and presented using prose and tables.

RESULTS AND DISCUSSION

Result
A total of 405 pregnant women aged 16 to 46 years participated in the study. Of the 405 participants, 25.9% (105 out of 405) tested positive for malaria parasites. The highest prevalence was recorded among women aged 16–20 years, with 80.0% (40/50) testing positive, while the lowest prevalence, 14.2% (2 / 14), was observed in the 41–46 years age group. Statistical analysis revealed a significant difference in prevalence of malaria parasitaemia across the different age groups ($p < 0.05$).

Table 1: Prevalence of Malaria among Pregnant Women Based on Age in Uyo

Age (yrs)	No. of Samples	Prevalence of Malaria		χ^2	p-value
		No. of Positive	Prevalence (%)		
16 – 20	50	40	80.0		
21 – 25	90	20	22.2		
26 – 30	125	22	17.6		
31 – 35	84	14	16.7	87.93	0.001
36 – 40	42	7	16.6		
41 – 46	14	2	14.2		
Total	405	105	25.9		

Table 2: Prevalence of Malaria among Pregnant Women by Gestational Trimesters and at Delivery in Uyo

Trimesters (months)	No. of Samples	Prevalence of Malaria		χ^2	p-value
		No. of Positive	Prevalence (%)		
1st (1 - 3)	61	29	47.5		
2nd (4 – 6)	152	38	25.0		
3rd (7 – 9)	86	20	23.2	19.64	0.002
Delivered	106	18	16.9		
Total	405	105	25.9		

A total of 106 women were delivered of their babies during the study period, and the birth weights of their newborns, based on the placental malaria status of the mothers, are presented in Table 3. Of the 106 parturient women, 16.9% (n = 18) tested positive for placental malaria parasitaemia, and their newborns had a mean birth weight of 2.23 kg (Table 3). The results showed that 83.0% (88/106) parturient mothers tested negative for placental malaria parasitaemia, and their newborns had a significantly higher mean birth weight of 3.73 kg (Table 3). The difference in birth weight between newborns of malaria-positive and malaria-negative parturient mothers was statistically significant ($p < 0.001$) (Table 3). Of the 18 women who tested positive for placental malaria parasitaemia, 27.7% (n = 5) delivered babies with a mean birth weight of 1.8 kg (range: 1.5 – 1.9 kg), 55.5% (n = 10) had babies with a mean birth weight of 2.3 kg (range: 2.0 – 2.49 kg), and 16.7% (n = 3) delivered babies with a mean birth weight of 2.6 kg (range: 2.5 – 2.9 kg). Of the 88 women who tested negative for placental malaria parasitaemia, 54.5% (n = 48) delivered babies with a mean birth weight of 3.3 kg (range: 3.0 – 3.4 kg), 39.7% (n = 35) had babies with a mean birth weight of 3.7 kg (range: 3.5 – 3.9 kg), and 5.7% (n = 5) delivered babies with a mean birth weight of 4.2 kg (range: 4.0 – 4.4 kg) (Table 3). Table 3 shows that the observed difference in birth weight distribution between malaria-positive and malaria-negative mothers was also statistically significant ($p = 0.013$).

Table 3: Newborn Birthweights in Relation to Maternal Placental Malaria Status in Uyo

Mothers Positive for Placental Malaria			Mothers Negative for Placental Malaria		
Newborn Birth Weight Range (kg)	Newborn Birth Weight Mean (kg)	No (%) of Placenta Malaria-Positive Mother	Newborn Birth Weight Range (kg)	Newborn Birth Weight Mean (kg)	No (%) Of Placenta Malaria-Negative Mother
1.5 - 1.9	1.8	5 (27.7)	3.0 - 3.4	3.3	48 (54.5)
2.0 - 2.4	2.3	10 (55.5)	3.5 – 3.9	3.7	35 (39.7)
2.5- 2.9	2.6	3 (16.7)	4.0 – 4.4	4.2	5 (5.6)

Discussion

This study assessed the prevalence of malaria parasitaemia among pregnant women and examined the impact of placental malaria on the birthweights of newborns in Uyo, Nigeria. A malaria prevalence rate of 25.9% was recorded among pregnant women, while 16.9% of those who delivered during the study period were positive for placental malaria. This represents a marked reduction compared to earlier reports from the same region, which documented prevalence rates of 54.7% and 41.0% (Ikpeze *et al*., 2016). The observed decline may be attributed to increased awareness and adoption of malaria preventive interventions, particularly the use of LLINs and Intermittent Preventive Treatment (IPT) among pregnant women.

The highest prevalence of malaria parasitaemia (40.0%) was observed in the 16–20 years age group and this is consistent with the findings of Melariri *et al.* (2024) who reported the highest burden of malaria parasitaemia among 83.3% of pregnant women between 16 - 20 years of age in Abia State. This age-specific trend may be associated with differences in acquired immunity, as younger women generally have lower cumulative exposure to malaria, resulting in weaker immune responses. In contrast, older women often acquire partial immunity through repeated exposure, which may contribute to the lower prevalence observed in older age groups (Omar *et. al*., 2021 and Melariri *et al.,* 2024). Similarly, Eneanya (1998) reported that younger individuals are more prone to malaria infection due to limited knowledge and practice of effective malaria prevention strategies, including the avoidance of mosquito bites. Behavioural factors, such as increased outdoor exposure without proper protection, may contribute to heightened exposure to malaria vectors among this demographic.

Malaria parasitaemia was most prevalent in the first trimester, with a rate of 47.5%, significantly higher than in the second and third trimesters. This result corroborates the findings of Jemikalajah (2017), Simon-Oke *et al.* (2019) and Melariri *et al.* (2024), which revealed that malaria parasitemia among pregnant women was prevalent in the first trimester at 87.5%, 75.5% and 28.6% respectively. It, however, contrasts with

findings of a study by Frank *et al* (2016) where malaria parasitemia was prevalent in the third trimester at 79.2%. The high prevalence of malaria parasitaemia in the first trimester may partly be due to the relatively small number of participants in that group, as many women in early pregnancy often delay registration for antenatal care. This underscores the need for intensified public health campaigns to encourage early antenatal attendance and the provision of free or subsidised maternal healthcare services to improve early registration and access to malaria prevention. The study further revealed that placental malaria was significantly associated with LBW. Also, 83.3% of newborns delivered by mothers with placental malaria weighed less than 2.5 kg. This finding is in agreement with previous reports by Oranuka *et al.* (2024) and Iwuchukwuu *et al*. (2021), which identified LBW as one of the severe outcomes of malaria parasitaemia in pregnancy. This has been attributed to the infiltration of monocytes into the placental intervillous space and the subsequent release of inflammatory cytokines, which may impair oxygen and nutrient transfer, leading to IUGR. Active placental infection is known to contribute to LBW through preterm delivery, while chronic infection more commonly causes IUGR. (Seitz *et. al.*, 2019). Steketee (2001) reported that in regions with stable malaria transmission, where maternal infection rates during pregnancy range between 10% and 65% malaria accounts for nearly 30% of all LBW cases, significantly impacting infant survival and development. Several studies have shown significant association between low birthweight and increased infant mortality and reveal that newborns with extremely low birth weight were 200 times more likely to die in the first year of life. (Saputri, *et al*., 2024, Jana *et. al.,* 2023 and Vilanova *et al.*, 2019). These findings highlight the critical importance of strengthening malaria prevention strategies during pregnancy to safeguard both maternal and neonatal health.

The study was conducted among women attending health facilities for antenatal care and delivery. Women who do not utilize health services were not represented, which may limit the generalizability of the findings to the broader population of pregnant women in the community.

CONCLUSION

The study found that malaria parasitaemia was most common in younger and first-trimester pregnant women and that placental malaria parasitaemia was strongly associated with low birthweight. These differences were statistically significant, highlighting the need for targeted malaria prevention and improved antenatal care to enhance birth outcomes. It is therefore recommended that malaria prevention efforts prioritise younger and first-trimester pregnant women through early antenatal booking and focused health education. Interventions such as intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine and consistent use of insecticide-treated nets (ITNs) should be intensified. Routine screening for malaria during ANC visits is essential and should be encouraged. Strengthening ANC services to ensure early detection and management of malaria will help reduce placental parasitemia and the associated risk of low birthweight, thereby improving maternal and neonatal health outcomes in malaria-endemic areas.

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CONSENT AND ETHICAL APPROVAL

This study was conducted in accordance with the guidelines of the National Health Research Ethics Committee (NHREC), and all procedures involving human subjects were approved by the Akwa Ibom State Ethical Committee, Ministry of Health (Approval No: MH/PRS/99/Vol.IV/142). Informed consent was obtained from each pregnant woman prior to participation.

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