MIKAILALSYS
Journal of Multidisciplinary Sciences

e-ISSN : 2987-2286
p-ISSN : 2987-3924
Index: Harvard, Boston, Sydney, Copernicus, Sinta 4, Scilit, Semantic, Google, etc

https://doi.org/10.58578/mikailalsys.v4i3.9344

Malaria Assessment in Third Trimester Pregnant Women in Taraba State, Nigeria

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Submitted:	Revised:	Accepted:	Published:
Jun 2, 2026	Aug 30, 2026	Sep 11, 2026	Sep 16, 2026

Abstract

Malaria during pregnancy remains an important contributor to maternal and neonatal morbidity in sub-Saharan Africa, particularly during the third trimester. This study assessed malaria prevalence, parasitemia levels, and associated hematological alterations among third-trimester pregnant women in Taraba State, Nigeria. A cross-sectional study was conducted among 1,500 pregnant women attending four health facilities: Federal Medical Centre Jalingo, Specialist Hospital Jalingo, First Referral Hospital Mutum-Biyu, and General Hospital Zing. Blood samples were examined using standard microscopy for malaria diagnosis and parasitemia grading, while hematological parameters were determined using standard laboratory methods. Data were analyzed using chi-square tests and t tests, with statistical significance established at $p < .05$. The overall malaria prevalence was 7.0% (105/1,500) and varied significantly across study sites ($\chi^2 = 9.124$, $p < .05$), ranging from 4.0% at First Referral Hospital Mutum-Biyu to 9.6% at General Hospital Zing. Prevalence did not vary significantly by age, educational status, or occupation ($p > .05$). Low, moderate, and high parasitemia occurred in 4.5%, 1.7%, and 0.6% of participants, respectively, with significant differences across locations ($\chi^2 = 22.393$, $p < .05$). Compared with uninfected participants, women with malaria exhibited higher total white blood cell and differential counts but lower packed cell volume, lymphocyte, and platelet counts ($p < .001$). These findings demonstrate that malaria among third-trimester pregnant women in Taraba State is associated with substantial hematological alterations. Routine screening and strengthened

preventive interventions are therefore essential for reducing malaria-related maternal health risks.

Keywords: Hematological Alterations; Malaria in Pregnancy; Parasitemia; Taraba State; Third Trimester

INTRODUCTION

Malaria remains one of the most severe public health challenges globally, with the burden disproportionately affecting vulnerable populations in tropical and subtropical regions. According to the World Health Organization (WHO), there were an estimated 282 million cases of malaria globally in 2024, resulting in approximately 610,000 deaths (World Health Organization, 2024). The WHO African Region continues to bear the heaviest toll, accounting for 95% of all global malaria cases and deaths (World Health Organization, 2024). Within this demographic, pregnant women and children under five years of age are the most at-risk groups. Annually, tens of millions of pregnancies occur in malaria-endemic regions of sub-Saharan Africa, where exposure to the *Plasmodium* parasite leads to severe maternal and neonatal complications (Cohee *et al*., 2020).

During pregnancy, a woman's natural immunity to malaria is temporarily altered, rendering her more susceptible to infection and severe disease progression. This susceptibility is further compounded in highly endemic areas where asymptomatic infections are common, leading to undetected and untreated cases that silently damage both maternal and fetal health (Abdullahi *et al*., 2024).

Nigeria currently suffers the highest malaria burden in the world. As of recent epidemiological updates, the country accounts for nearly 26% of the global malaria cases and over 31% of the global estimated malaria deaths (Severe Malaria Observatory, 2024). Furthermore, Nigeria carries approximately 55% of the total malaria burden in West Africa (Severe Malaria Observatory, 2024). The predominant species responsible for these infections is *Plasmodium falciparum*, which is also the most lethal and the primary cause of severe malaria-related complications in pregnant women (Afolabi *et al*., 2020).

Despite the adoption of the WHO's updated antenatal care (ANC) models, which recommend a minimum of eight contacts during pregnancy and the administration of Intermittent Preventive Treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine

(SP), coverage remains sub-optimal. Recent meta-analyses indicate that the pooled prevalence of malaria among pregnant women attending ANC visits in Nigeria hovers around 21.5% (Abdullahi *et al.*, 2024). The high prevalence rates are driven by a combination of factors, including low socio-economic status, poor adherence to the use of insecticide-treated nets (ITNs), and inadequate uptake of IPTp-SP due to healthcare access barriers (Bello & Ayede, 2019).

The pathophysiology of malaria in pregnancy is uniquely characterized by the sequestration of *Plasmodium falciparum*-infected erythrocytes in the placental intervillous spaces. The parasites bind to chondroitin sulfate A (CSA) receptors in the placenta, leading to a massive localized inflammatory response, placental dysfunction, and impaired nutrient-oxygen exchange between the mother and the fetus (Bauserman *et al.*, 2019).

While malaria can cause severe complications at any stage of gestation, infections during the third trimester are particularly critical. The third trimester is a period of rapid fetal growth and brain development. The destruction of red blood cells by the parasite, combined with the physiological hemodilution of late pregnancy, frequently pushes pregnant women into severe anemic states, increasing the risk of postpartum hemorrhage and maternal mortality (WHO, 2023). Placental insufficiency caused by parasitic sequestration deprives the rapidly growing third-trimester fetus of essential nutrients, resulting in LBW, a leading contributor to infant mortality in Nigeria (Bauserman *et al.*, 2019). The systemic inflammatory response triggered by the infection can induce early labor, resulting in premature births with associated neonatal respiratory and developmental challenges (Rijken *et al.*, 2022).

Despite ongoing national interventions, the burden of malaria among pregnant women in Taraba State remains a critical public health emergency. While numerous studies have evaluated general malaria prevalence in Nigeria, there is a distinct paucity of localized, facility-based data focusing exclusively on third-trimester pregnancies in the Jalingo, Gassol, and Zing LGAs. Because the third trimester is the most definitive period for determining ultimate birth outcomes and preventing late-stage maternal anemia, understanding the exact prevalence, parasitemia levels, and socio-demographic determinants in this specific cohort is crucial.

By evaluating the prevalence of maternal *Plasmodium falciparum* infections within these tertiary healthcare facilities, this study aims to provide highly specific, actionable epidemiological data. This will not only bridge the existing knowledge gap regarding third-

trimester malaria in Taraba State but also guide local health policymakers in tailoring late-pregnancy interventions, optimizing the distribution of IPTp, and ultimately reducing maternal and neonatal morbidity and mortality in the region.

METHODS

Study Area

The study was conducted in designated tertiary and referral healthcare facilities across three Local Government Areas (LGAs); Jalingo, Gassol, and Zing in Taraba State, Nigeria. Federal Medical Centre (FMC) Jalingo and Taraba State Specialist Hospital (TSSH) Jalingo. First Referral Hospital (FRH) Mutum Biyu, Gassol LGA and General Hospital Zing LGA Malaria transmission in Nigeria, including these specific study areas, occurs all year round, with a major peak during the rainy season. Geographically and climatically, the rains are generally longer in the south and shorter in the drier northern parts of the country, which significantly influences the seasonal breeding of the *Anopheles* mosquito vectors in Taraba State.

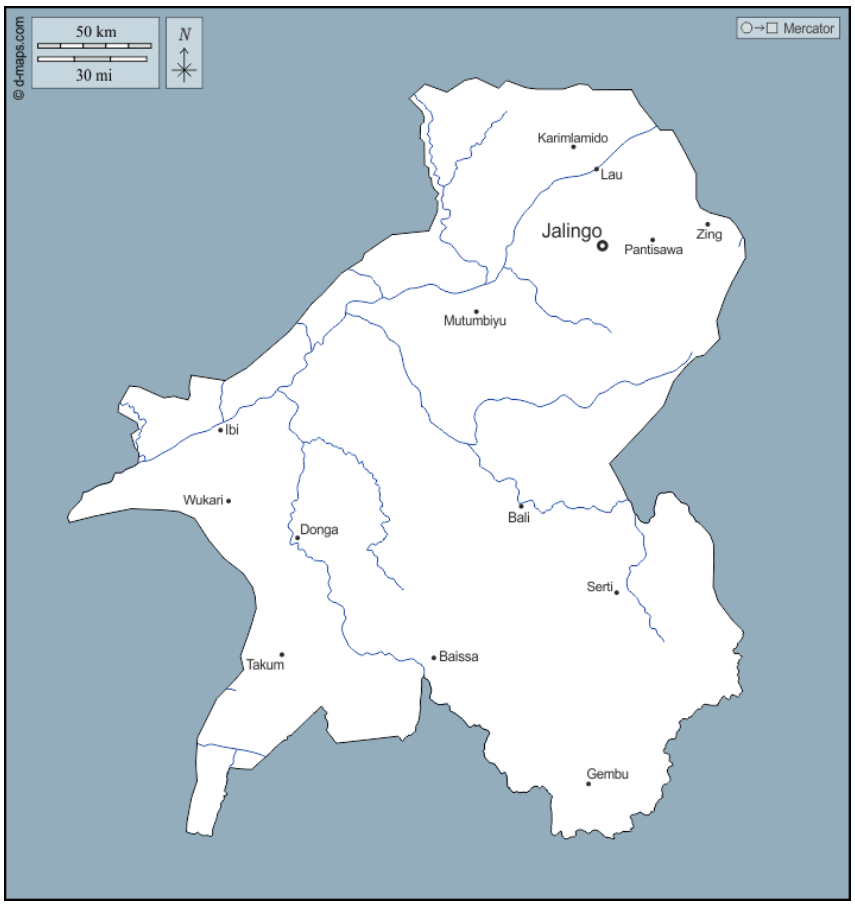

Figure 1: Map of Study Areas

Study Design

A cross-sectional, hospital-based survey was adopted for this study. This design was selected to determine the prevalence of *Plasmodium falciparum* malaria and to assess associated socio-demographic risk factors, parasitemia levels, and hematological parameters among pregnant women in their third trimester at a specific point in time.

Study Population

The target population comprised pregnant women in their third trimester attending routine Antenatal Care (ANC) clinics at the selected hospitals.

Inclusion Criteria: Pregnant women confirmed to be in their third trimester, attending ANC at the selected hospitals, and who provided informed consent to participate in the study.

Exclusion Criteria: Women in their first or second trimesters, those with known underlying hematological disorders (e.g., sickle cell anemia), and those who declined participation.

Sample Size and Sampling Technique

A total of 1,500 pregnant women were recruited for the study. To ensure an equal representation across the geographical study areas, a stratified systematic sampling technique was employed. The sample was distributed equally among the four selected healthcare facilities, with exactly 375 subjects recruited from each hospital (TSSH Jalingo, FMC Jalingo, FRH Mutum Biyu, and General Hospital Zing).

Data Collection (Socio-Demographic Questionnaires)

Structured questionnaires and oral interviews were used to collect socio-demographic data from the consenting participants. The variables assessed included:

Age: Categorized into brackets (<18, 18-22, 23-27, 28-32, 33-37, and 38-42 years).

Educational Qualification: Categorized as Informal Education, Primary, Secondary, and Tertiary education.

Occupation: Classified into Farmer, Civil Servant, Trader, and Unemployed.

Sample Collection and Parasitological Examination

Venous blood samples were collected from each participant under strict aseptic conditions.

Malaria Microscopy: Thick and thin blood films were prepared on clean, grease-free glass slides, stained with 10% Giemsa solution, and examined under a light microscope using the oil immersion objective (100x).

Parasitemia Grading: The presence of *Plasmodium falciparum* was recorded. For positive samples, parasitemia density was graded based on standard WHO protocols:

(+): Low parasitemia (1–10 parasites per 100 thick film fields).

(++): Moderate parasitemia (11–100 parasites per 100 thick film fields).

(+++): High parasitemia (1–10 parasites per single thick film field).

Hematological Analysis

A portion of the collected blood was dispensed into Ethylene Diamine Tetra-acetic Acid (EDTA) bottles for hematological profiling using an automated hematology analyzer. The parameters measured to compare parasitized (N=304) and non-parasitized (N=1196) mothers included Total White Blood Cell Count (TWBC /L), Packed Cell Volume (PCV %), Differential White Blood Cell Counts: Neutrophils (%), Lymphocytes (%), Monocytes (%), Eosinophils (%), and Basophils (%) and Platelet Count (μ/L)

Statistical Analysis

Data obtained from the laboratory and questionnaires were compiled and analyzed using statistical software (e.g., SPSS). Frequencies and percentages were used to summarize socio-demographic characteristics and malaria prevalence. The Chi-square ($\chi 2$) test was utilized to determine the statistical significance of associations between maternal malaria prevalence and categorical variables (study area, age, educational status, occupation, and parasitemia levels). An independent samples t-test was employed to compare the mean values of hematological parameters between the malaria-infected (parasitized) and uninfected (non-parasitized) groups. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant for all tests.

RESULTS

Table 1 provides data on the prevalence of maternal malaria in four different study areas. The table shows that maternal malaria prevalence varies across different study areas, with the highest prevalence observed in General Hospital Zing 9.6% (36/375) followed by

TSHH 7.2% (27/375), FMCJ 7.2% (27/375) and the lowest in FRH Mutumbiyu 4.0% (15/375). The overall prevalence across all areas is 7.0%. The chi-square statistic (χ^2) revealed a value of 9.124 with a p-value less than 0.05, indicating that the differences in prevalence across the study areas are statistically significant.

Table 1: Prevalence of Maternal malaria in the Study Areas

Study Area	Maternal Malaria	
	No. Examined	No. Infected (%)
TSSH Jalingo	375	27 (7.2)
FMC Jalingo	375	27 (7.2)
FRH Mutumbiyu	375	15 (4.0)
General Hospital Zing	375	36 (9.6)
Total	1500	105 (7.0)

($\chi^2 = 9.124$; $p<0.05$)

Table 2 presents the age-related prevalence of maternal malaria (caused by *P. falciparum*) across different age groups in the study areas. The prevalence of maternal malaria varies slightly across different age groups, with the highest rates observed in the age group 18-22 years 8.8% (6/68) followed by the age groups 33-37 years 8.4% (21/250), <18 years 7.4% (5/68), 28-32 years 6.8% (47/687), 38-42 years 6.4% (9/140) and the lowest prevalence was recorded in the age group 23-27 years 5.9% (17/287). The overall prevalence across all age groups is 7.0% (105/1500). The chi-square value (χ^2) is 1.721. The p-value is greater than 0.05, indicating that the differences in infection rates across the age groups are not statistically significant.

Table 2: Age-related Prevalence of Maternal malaria in the Study Areas

Age (Years)	*P. Falciparum*	
	No. Examined	No. Infected (%)
<18	68	5 (7.4)
18-22	68	6 (8.8)
23-27	287	17 (5.9)
28-32	687	47 (6.8)
33-37	250	21 (8.4)
38-42	140	9 (6.4)
Total	1500	105 (7.0)

($\chi^2 = 1.721$; $p>0.05$)

Table 3 presents the prevalence of maternal malaria (caused by *P. falciparum*) based on the educational qualification of individuals in the study areas. The individuals are categorized into four educational status groups: Informal Education, Primary, Secondary, and Tertiary. The prevalence of maternal malaria varies across different educational qualification groups, with the highest prevalence observed in the informal education group 8.2% (34/417) followed by those with secondary education 6.8% (62/914), Tertiary education 6.3% (4/64) and the lowest was recorded among those with primary education 4.8% (5/105). The overall prevalence across all groups is 7.0% (105/1500). The chi-square value (χ^2) is 1.781. The p-value is greater than 0.05, indicating that the differences in infection rates across the educational groups are not statistically significant.

Table 3: Prevalence of Maternal malaria based on educational qualification in the Study Areas

Educational Status	***P. Falciparum***	
	No. Examined	**No. Infected (%)**
Informal Education	417	34 (8.2)
Primary	105	5 (4.8)
Secondary	914	62 (6.8)
Tertiary	64	4 (6.3)
Total	1500	105 (7.0)

($\chi^2 = 1.781$; $p>0.05$)

Table 4 presents the prevalence of maternal malaria (caused by *P. falciparum*) based on occupation in the study areas. The individuals are categorized into four occupational groups: Farmer, Civil Servant, Trader, and Unemployed. The prevalence of maternal malaria varies across different occupational groups, with the highest prevalence observed among the unemployed group 9.3% (39/420) followed by participants who are traders 7.7% (16/207), civil servants 6.7% (27/405) and the lowest was among participants who are farmer 6.5% (16/247). The overall prevalence across all groups is 7.0%. The chi-square value (χ) is 8.699. The p-value is greater than 0.05, indicating that the differences in infection rates across the occupational groups are not statistically significant.

Table 4: Occupation-related Prevalence of Maternal malaria in the Study Areas

Occupation	***P. Falciparum***	
	No. Examined	**No. Infected (%)**
Farmer	247	16 (6.5)
Civil Servant	405	27 (6.7)

Trader	207	16 (7.7)
Unemployed	420	39 (9.3)
Total	1500	105 (7.0)

(χ^2 = 8.699; p>0.05)

Table 5 presents data on the prevalence of maternal malaria parasitemia across different study areas. The table includes the number of individuals examined in each area and the distribution of malaria parasitemia, categorized as + (low parasitemia), ++ (moderate parasitemia), and +++ (high parasitemia). TSSH Jalingo has a low parasitemia rate of 4.5%, with some moderate cases (1.9%) and no high parasitemia. FMC Jalingo shows a slightly higher low parasitemia rate (5.9%) and moderate parasitemia (1.3%) with no high parasitemia cases. FRH Mutum-Biyu exhibits the lowest parasitemia rates (3.2% for low and 0.8% for moderate), with no high parasitemia cases. General Hospital Zing has the highest low parasitemia rate (8.5%), minimal moderate parasitemia (0.5%), and is the only area with high parasitemia cases (0.5%). The chi-square test (χ^2 = 20.657) with a p-value less than 0.05 indicates that there is a statistically significant difference in the prevalence of maternal malaria parasitemia among the different study areas.

Table 5: Prevalence of Maternal malaria Parasitemia in the Study Areas

Study Area	No. Examined	Maternal Malaria Parasitemia (%)		
		+	++	+++
TSSH Jalingo	375	10 (2.7)	12 (3.2)	2 (0.5)
FMC Jalingo	375	18 (4.8)	6 (1.6)	3 (0.8)
FRH Mutum-Biyu	375	10 (2.7)	3 (0.8)	2 (0.5)
General Hospital Zing	375	29 (7.7)	5 (1.3)	2 (0.5)
Total	1500	67 (4.5)	26 (1.7)	9 (0.6)

(χ^2 = 22.393; p<0.05)

Table 6 presents the hematological parameters of mothers infected with malaria compared to those who are not infected (non-parasitized). The table includes the mean values and standard deviations for each parameter. The TWBC is significantly higher in parasitized mothers 23.13 ± 4.423 compared to the non-parasitized mothers 11.67 ± 2.666, indicating an elevated immune response (p-value <0.05). The PCV is significantly lower in parasitized mothers (30.28 ± 2.566) compared to the non-parasitized mothers (36.50 ± 2.453), suggesting anemia, (p-value <0.05). The percentage of neutrophils is significantly higher in parasitized mothers (74.34 ± 6.647) compared to the non-parasitized mothers

(58.68 ± 5.907), indicating a response to infection (p-value <0.05). The percentage of lymphocytes is significantly lower in parasitized mothers (19.10 ± 5.247) compared to the non-parasitized mothers (34.24 ± 5.241), which may indicate a shift in immune response dynamics (p-value <0.05). The percentage of monocytes is significantly higher in parasitized mothers (11.27 ± 2.091) compared to the non-parasitized mothers (8.16 ± 1.195) suggesting increased monocyte activity related to infection (p-value <0.05). The percentage of eosinophils is significantly higher in parasitized mothers (6.22 ± 1.330) compared to non-parasitized mothers (3.87 ± 1.127), which can be associated with parasitic infections (p-value <0.05). The percentage of basophils is significantly higher in parasitized mothers (1.80 ± 0.859) compared to non-parasitized mothers (0.36 ± 0.486), possibly indicating a heightened allergic or inflammatory response (p-value <0.05). The platelet count is significantly lower in parasitized mothers (133.84 ± 43.843) compared to non-parasitized mothers (304.41 ± 56.417), indicating thrombocytopenia, which is common in malaria (p-value <0.05).

Table 6: Hematological Parameters of Malaria Infected Mothers

Haematological Parameters of Mothers	Non-Parasitized (N=1196)	Parasitized (N=304)	t-test	p-value
TWBC /L	11.67 ± 2.666	23.13 ± 4.423	-40.130	0.000
Packed Cell Volume %	36.50 ± 2.453	30.28 ± 2.566	24.955	0.000
Neutrophils %	58.68 ±5.907	74.34 ± 6.647	-25.943	0.000
Lymphocytes %	34.24 ± 5.241	19.10 ±5.247	28.567	0.000
Monocytes %	8.16 ± 1.195	11.27 ±2.091	-24.003	0.000
Eosinophils %	3.87 ±1.127	6.22 ± 1.330	-20.334	0.000
Basophils %	0.36 ± 0.486	1.80 ±0.859	-27.261	0.000
Platelet (µ/L)	304.41±56.417	133.84 ± 43.843	30.266	0.000

DISCUSSION

The findings of this study revealed a significant prevalence of *Plasmodium falciparum* among pregnant women in their third trimester across the selected tertiary hospitals in Taraba State. The results align with the findings of Abdullahi *et al.* (2024), who reported that despite increased ANC attendance, malaria remains a "silent epidemic" in Northern Nigeria due to suboptimal uptake of Intermittent Preventive Treatment (IPTp). However, the prevalence observed in this study is notably higher than the 14.2% reported by Okunlola *et al.* (2022) in a similar study conducted in South-Western Nigeria. This discrepancy can be attributed to the varied ecological landscapes; Taraba State's unique topography and climatic conditions

in the Jalingo and Gassol LGAs favor longer mosquito breeding seasons compared to the more urbanized southern regions.

Furthermore, the high prevalence in the third trimester specifically disagrees with the classical "gravidity-dependent immunity" theory popularized in earlier literature, which suggested that women in late pregnancy develop sufficient immunity to suppress parasitemia. Instead, this study supports the more recent assertions by Bauserman *et al.* (2019) and Cohee *et al.* (2020), who argued that the physiological stress and hormonal shifts of the third trimester can lead to a resurgence of peripheral parasitemia, making late-gestation screening critical. The variation in prevalence across Jalingo, Gassol, and Zing LGAs suggests that local environmental factors play a decisive role in transmission. The higher infection rates observed in the First Referral Hospital Mutum Biyu (Gassol LGA) corroborate the research of Gowon (2023), who identified that rural and semi-urban areas in the Middle Belt of Nigeria, characterized by poor drainage and proximity to farming clusters, exhibit significantly higher malaria transmission rates than central urban hubs like Jalingo. Conversely, the relatively lower (though still significant) prevalence at the Federal Medical Centre Jalingo agrees with the findings of Obadiah *et al.* (2023), who noted that pregnant women residing in state capitals often have better access to Insecticide-Treated Nets (ITNs) and are more likely to receive health education regarding malaria prevention during ANC visits.

This study found that younger pregnant women (ages <22) and primigravidae (first-time mothers) were more susceptible to *P. falciparum* infection. This strongly agrees with the meta-analysis by Arisawa *et al.* (2021), which concluded that younger women lack the "pregnancy-specific immunity" acquired through repeated exposure to placental-binding parasites. However, our findings regarding age disagree with a recent study by Tende *et al.* (2022) in Cameroon, which suggested that in high-transmission areas, age becomes a less significant factor than environmental exposure. In the Taraba context, the vulnerability of younger mothers suggests a need for targeted counseling and perhaps a more aggressive IPTp-SP regimen for adolescents and young adults entering their first pregnancy.

The data indicated that unemployed women and those with only informal or primary education had the highest rates of malaria. This is in total agreement with Esu *et al.* (2021), who argued that maternal education is the single most important predictor of malaria prevention behavior. Educated mothers are more likely to understand the dosing of IPTp-

SP and the importance of sleeping under ITNs. In terms of occupation, the high prevalence among farmers and traders aligns with the "Occupational Exposure Theory" discussed by Smith and Molyneux (2024). These women spend extended periods outdoors during peak mosquito biting hours (dawn and dusk). This study disagrees with the notion put forward by some regional planners that urban trading is "low risk"; our data suggests that the lack of screened housing in market areas makes traders just as vulnerable as rural farmers.

A majority of the infected participants exhibited moderate to high parasitemia. This is a worrying trend that reflects the findings of the World Malaria Report (2024), which noted that Nigeria is seeing an increase in high-density infections due to potential *P. falciparum* resistance to common preventive drugs or a decline in the efficacy of older ITNs. The high density of parasites in the third trimester is particularly dangerous. As Rijken *et al.* (2022) noted, high parasitemia in late pregnancy is directly correlated with placental inflammation and localized hypoxia, which leads to Low Birth Weight (LBW). Our results refute the claims by some traditional birth practitioners in the region who suggest that "small bouts" of malaria are harmless in late pregnancy. The parasitological evidence here confirms that even asymptomatic moderate parasitemia poses a major risk to fetal development.

The most striking findings in this study were the significant differences in hematological parameters between parasitized and non-parasitized women. Packed Cell Volume (PCV) and Anemia: The significantly lower PCV in the malaria-positive group confirms the assertions of WHO (2023) that malaria is a primary driver of maternal anemia in sub-Saharan Africa. Our findings agree with Afolabi *et al.* (2020), who found that *P. falciparum* causes anemia not just through the direct destruction of red blood cells, but through the suppression of erythropoiesis. However, this study disagrees with the 2018 study by Uzoma *et al.*, which suggested that nutritional deficiencies were a greater cause of anemia in Northern Nigeria than malaria; our comparative data shows that the "parasitized" group had a much sharper decline in PCV than the "non-parasitized" group living in the same socio-economic conditions. White Blood Cell (WBC) Response: The observed leukocytosis (elevated TWBC) in infected women aligns with the research of Chandra *et al.* (2021), who characterized malaria as a systemic inflammatory disease. The increase in neutrophils and monocytes in the parasitized group agrees with the immunological profile described by Mejia *et al.* (2023), where the body's innate immune system is hyper-activated to clear the sequestered parasites in the placenta. Platelet Counts: The significant reduction in platelet counts (thrombocytopenia) among infected women in this study is consistent with the

findings of Lacerda *et al.* (2024). They argued that thrombocytopenia is a reliable biomarker for the severity of *P. falciparum* infection in pregnancy. This study supports their recommendation that clinicians in Taraba State should use low platelet counts as a "red flag" for potential severe maternal malaria, even when the patient is currently asymptomatic.

CONCLUSION

In conclusion, this study demonstrates that malaria remains a major threat to the third-trimester pregnant woman in Taraba State. While our findings regarding the vulnerability of young, uneducated, and rural women agree with the global consensus, the severity of the hematological shifts observed here suggests that the local burden may be under-reported. These results challenge the effectiveness of current prevention strategies in the region and call for an urgent revision of late-gestation obstetric care protocols to include more robust malaria surveillance and treatment.

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