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Epidemiological Patterns of Malaria Infection Among Pregnant Women in Benue State

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Abstract

Malaria remains a major public health issue in Nigeria, particularly among pregnant women, due to the high risk of maternal and neonatal complications associated with Plasmodium infections. This cross-sectional study investigates the epidemiological distribution and infection rates of Plasmodium species among 300 pregnant women attending antenatal clinics in selected primary healthcare facilities across six local government areas in Benue State, Nigeria. Data collection involved structured questionnaires capturing socio-demographic and obstetric characteristics, alongside blood sample analysis using microscopy and Rapid Diagnostic Tests (RDTs). Results revealed an overall Plasmodium infection prevalence of 34.3%, with Plasmodium falciparum being the predominant species (30.7%). The study also identified the presence of Plasmodium malariae (2.3%), Plasmodium ovale (0.7%), and Plasmodium knowlesi (0.7%), while no cases of Plasmodium vivax were detected. Infection rates varied significantly across different socio-demographic factors: rural residents exhibited higher infection rates (39.3%) compared to their urban counterparts (23.4%), and younger pregnant women (aged 17-22) had the highest prevalence (39.7%). Socioeconomic factors such as education and occupation also played a critical role; women with informal education had a notably higher prevalence (51.1%) compared to those with tertiary education (25%). Among occupations, farmers had the highest infection rate (38.1%). This study underscores the multifaceted influences on malaria prevalence in pregnancy, including environmental, educational, and socioeconomic determinants, emphasizing the need for targeted malaria control strategies. These strategies should include increased access to insecticide-treated nets, better healthcare services in rural areas, and comprehensive health education campaigns to improve awareness and preventive measures among vulnerable populations. The findings highlight critical areas for public health interventions aimed at reducing malaria infections among pregnant women, ultimately improving maternal and fetal health outcomes.

Keywords: Malaria epidemiology, Plasmodium species, Pregnancy, Malaria, Primary healthcare, Materal health.

1. Introduction

Malaria remains a critical public health challenge, particularly in tropical and subtropical regions where climatic conditions favor the breeding of *Anopheles* mosquitoes the primary vectors of the disease [1]. Nigeria bears a significant share of the global malaria burden, with the disease accounting for a substantial proportion of national morbidity and mortality [2]. Malaria is caused by Plasmodium parasites, of which *Plasmodium falciparum* is the most prevalent and deadliest species in sub-Saharan Africa [3]. Pregnant women are among the most vulnerable groups due to immunological changes and reduced resistance during pregnancy, which heighten their susceptibility to malaria infection [4]. The consequences of malaria in pregnancy are severe, often leading to complications such as maternal anemia, placental malaria, spontaneous abortion, stillbirth, preterm delivery, and low birth weight [5].

In Benue State, Nigeria, the prevalence of malaria among pregnant women remains alarmingly high, particularly in primary healthcare settings [6]. The persistence of malaria in this population is influenced by several factors, including socio-economic conditions, proximity to mosquito breeding sites, limited healthcare access, and inconsistent use of preventive measures such as insecticide-treated nets (ITNs) and intermittent preventive treatment (IPT) [7]. Previous studies have highlighted the urgent need for effective malaria control measures tailored to local contexts, with a focus on primary healthcare facilities where resource constraints often limit comprehensive care [8].

This study is significant because it provides crucial insights into the epidemiological patterns of malaria among pregnant women in Benue State, focusing on primary healthcare settings. By identifying the prevalence of various Plasmodium species and analyzing socio-economic and demographic factors that influence infection rates, the research highlights areas and populations at greatest risk. This knowledge is essential for developing targeted public health interventions aimed at reducing malaria transmission and improving maternal and neonatal health outcomes. Furthermore, the study underscores the importance of strengthening primary healthcare services and implementing effective preventive strategies, such as the distribution and utilization of insecticide-treated nets and intermittent preventive treatment during pregnancy. By addressing gaps in existing malaria control efforts, this research contributes to the broader goal of reducing the malaria burden in Nigeria and enhancing the well-being of pregnant women and their families.

2. Materials and Methods

2.1 Study Area

This study was conducted across six primary healthcare centers in Benue State, Nigeria, chosen for their reported high malaria prevalence and favorable conditions for mosquito

breeding. The selected sites were: Makurdi, Gboko, Katsina-Ala, Vandeikya, Otukpo, and Ogbadibo. Benue State, with an estimated population of about 4.25 million, predominantly consists of Tiv, Idoma, Igede, and Etulo ethnic groups. The climate and geography of these areas include adequate rainfall and moderate temperatures, creating conducive conditions for the Anopheles mosquito, the primary vector for malaria transmission. The choice of these sites allows the study to represent diverse socio-ecological conditions within Benue State, where malaria has been a significant health burden among pregnant women.

2.2 Research Design

The study utilized a cross-sectional survey design, conducted over 13 months from February 2020 to March 2021. This timeframe allowed for data collection across different seasons, which can influence malaria transmission rates due to changing weather patterns and mosquito breeding cycles. The primary healthcare-based design ensures that findings are representative of community health outcomes, as primary centers often cater to the majority of pregnant women in rural and peri-urban areas.

2.3 Sampling Technique

2.3.1 Target Population

The study focused on approximately 3,000 pregnant women attending antenatal care (ANC) clinics in the selected healthcare facilities.

2.3.2 Sample Size

A statistically significant sample size of 300 pregnant women was selected, representing 10% of the target population. This sample size was determined based on population estimates and feasibility, ensuring a balanced representation across different socioeconomic backgrounds and healthcare centers.

2.3.3 Sampling Method

Participants were selected using a simple random sampling technique, which minimizes selection bias and ensures a diverse cross-section of pregnant women in terms of age, parity, residence, and socio-economic status.

2.3.4 Informed Consent

Ethical clearance was obtained from the Department of Zoology and the Primary Health Management Board of Benue State. Pre-survey visits were made to each facility to secure permission from the management teams and introduce the study objectives. During these visits, healthcare workers and laboratory staff were briefed on the study's nature, significance, and procedures to foster their collaboration. Informed consent was then obtained from each participating pregnant woman after explaining the study's aims, procedures, potential risks, and benefits, ensuring voluntary participation.

2.4 Data Collection

2.4.1 Questionnaire Administration

A structured questionnaire was designed to capture demographic and socio-economic information, such as age, education level, gravidity (number of pregnancies), stage of pregnancy, occupation, and usage of malaria preventive measures (e.g., bed nets or antimalarial prophylaxis). Data were collected directly at ANC clinics, with assistance from healthcare staff to ensure accurate recording and support for participants with limited literacy.

2.4.2 Blood Sample Collection and Preparation

Blood samples were collected under sterile conditions. The skin at the collection site was swabbed with 70% alcohol before collecting capillary blood through a finger prick for the rapid diagnostic test (RDT) and for microscopy.

2.4.3 Rapid Diagnostic Test (RDT)

A small amount of blood was tested using the SD Bioline malaria RDT kit, specifically designed to detect Plasmodium falciparum. The test was conducted by placing a blood sample in the designated sample well and adding an assay buffer. The results were read after 20 minutes, with two color bands indicating a positive result.

2.4.4 Microscopy

For microscopic diagnosis, both thick and thin blood smears were prepared on glass slides. Thin films were fixed with methanol, and both slides were stained with 5% Giemsa solution for species identification and quantification. Experienced laboratory technologists, blinded to the RDT results, examined the slides. Thick smears helped estimate parasite density, while thin smears confirmed Plasmodium species.

2.5 Data Analysis

Data were initially recorded in Microsoft Excel and subsequently analyzed using Minitab software (version 17.0). Statistical tests, including chi-square tests, were used to evaluate associations between malaria infection rates and variables such as location, age, parity, educational background, and residence. A 95% confidence limit ($p \leq 0.05$) was applied to determine statistical significance. Chi-square graphs and distribution curves were plotted to visualize the infection rates across different demographic groups, helping identify specific at-risk populations and the efficacy of preventive measures.

3. Results

Among the 300 pregnant women sampled, 34.3% tested positive for malaria, predominantly *Plasmodium falciparum* (30.7%), followed by *Plasmodium malariae* (2.3%), *Plasmodium ovale* (0.7%), and *Plasmodium knowlesi* (0.7%).

The study was conducted across six primary healthcare centers in Benue State (Makurdi, Gboko, Katsina-Ala, Vandeikya, Otukpo, and Ogbadibo). Infection rates varied by

location, with Katsina-Ala showing the highest infection rate at 50%, primarily by P. falciparum.
Higher infection rates were observed in rural areas (39.3%) compared to urban areas (23.4%). Rural areas reported cases of P. ovale and P. knowlesi, which were not found in urban areas.

Pregnant women aged 17-22 years had the highest infection rate (39.7%), followed by those in the 23-28 years group (31.4%). Infections decreased in older age groups.

Women with informal education showed the highest infection rates (51.1%) across all Plasmodium species. A significant association was found between education level and malaria infection rates.

Farmers had the highest infection rate (38.1%) among different occupational groups, followed by traders (34.2%) and students (33.3%).

Malaria prevention strategies such as the use of insecticide-treated nets (ITNs) and intermittent preventive treatment were discussed but appeared underutilized, especially in rural settings.

These findings emphasize the prevalence of malaria among pregnant women in Benue State and highlight significant associations with location, socioeconomic factors, and preventive measure accessibility.

Table 1: Infection Rates of *Plasmodium* Species Among Pregnant Women Attending Antenatal Clinics in Selected Primary Health Care (PHC) Facilities Across Benue State in Relation to Location.

PHC locations	Total Number examined	No of *P. falciparum* positive (%)	No of *P. malariae* positive (%)	No of *P. ovale* positive (%)	No of *P,knowlesi* positive (%)	No of *P. vivax* positive (%)	Total No.positive (%)	No of Negative (%)
Makurdi	69	19 (27.5)	4 (5.8)	2 (2.9)	0 (0.0)	0 (0.0)	25 (36.2)	44 (63.8)
Gboko	13	4 (30.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (30.8)	9 (69.8)
Vadeikya	31	11 (35.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	11 (35.5)	20 (64. 5)
Katsina-Ala	10	5 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (50.0)	5 (50.0)
Otukpo	163	48 (29.4)	3 (1.8)	0 (0.0)	2 (1.2)	0 (0.0)	53 (32.5)	110 (67.5)
Ogbadibo	14	`5 (35.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (35.7)	9 (64.3)
Total	300	92 (30.7)	7 (2.3)	2 (0.7)	2 (0.7)	0 (0.0)	103 (34.3)	197 (65.7)

χ^2_{5df} (PHC locations and % *P. falciparum*) = 9.50, P= 0.091 (P>0.05)
χ^2_{5df} (PHC locations and % Total *Plasmodium* infection) = 6.31, P= 0.277 (P>0.05)

Inference

- No significant association between PHC locations and % *P. falciparum*(P>0.05)
- No significant association between PHC locations and % Total *Plasmodium* infection(P>0.05)

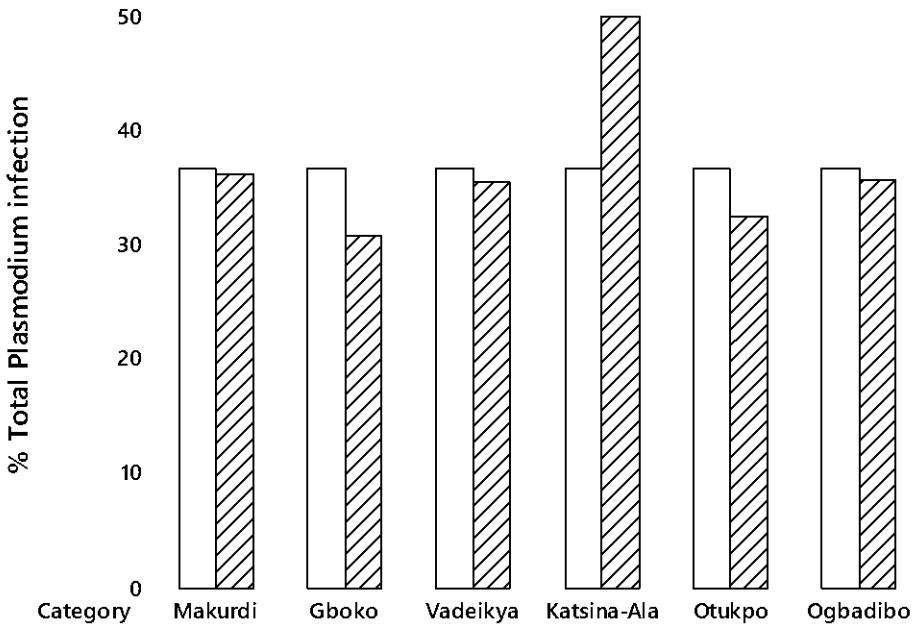

Figure 1: Distribution of Percentage Total *Plasmodium* Infection Based on Locations of Primary Health Care

Note:

Higher observed than expected value=**Katsina-Ala**

Table 2: Infection Rates of *Plasmodium* species Among Pregnant Women Attending Antenatal Clinic in Selected Primary Health Care (PHC) Facilities Across Benue State in Respect to Residence

χ^2_{1df} (Residence and % *P. falciparum*) = 3.33, P= 0.068 (P>0.05)

Residence	Total number examined	No positive with *P.falciparium* (%)	No positive with *P. malariae* (%)	No positive with *P. ovale*	No positive with *P. knowlesi* (%)	No positive with *P. vivax* (%)	Total No Positive (%)	No of Negative (%)
Urban	94	20 (21.3)	2 (2.1)	0 (0.0)	0 (0.0)	0 (0.0)	22 (23.4)	72 (76.6)
Rural	206	72 (35.0)	5 (2.4)	2 (1.0)	2 (1.0)	0 (0.0)	81 (39.3)	125 (60.7)
Total	300	92 (30.7)	7 (2.3)	2 (0.7)	2 (0.7)	0 (0.0)	103 (34.3)	197 (65.7)

χ^2_{1df} (Residence and % Total *Plasmodium* infection) = 4.03, P= 0.045 (P<0.05)

Inference

- No significant association between Residence and % *P. falciparum*(P>0.05)
- Total *Plasmodium* infection is significantly associated with residence *(*P<0.05)

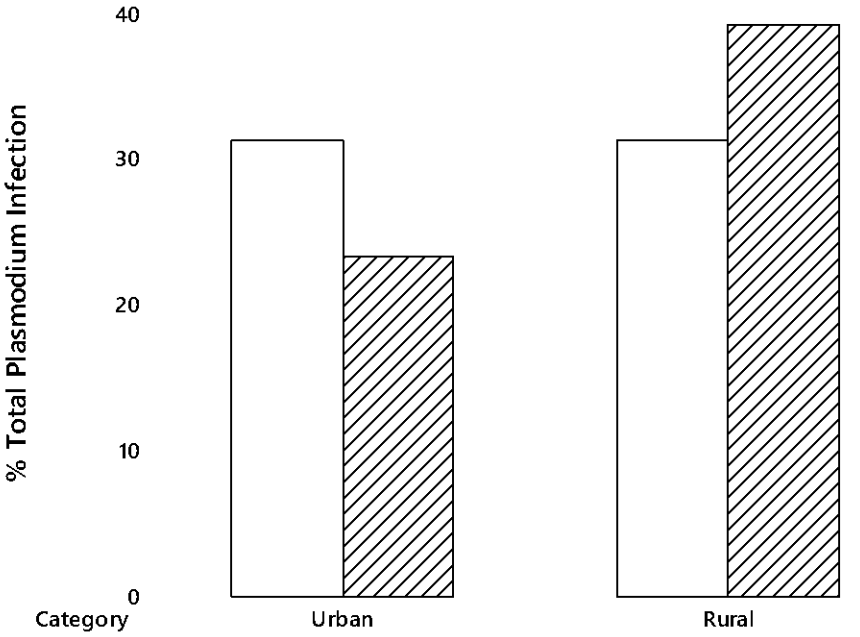

Figure 2: Percentage Total *Plasmodium* Infection Based on Residence

Note:Higher observed than expected value = **Rural residence**

Table 3: Infection Rates of *Plasmodium* species Among Pregnant Women Attending Antenatal Clinics in Selected Primary Health Care (PHC) Facilities Across Benue State in Respect to Age

Age Groups	Total number examined	No positive with *P. falciparum*(%)	No positive with *P. malariae* (%)	No positive with *P. ovale*(%)	No positive with *P. knowlesi* (%)	No positive with *P. vivax* (%)	Total No of Positive (%)	No Negative (%)
17 – 22	98	34 (34.7)	3 (3.1)	1 (1.0)	1 (1.0)	0 (0.0)	39 (39.7)	59 (60.2)
23 – 28	140	41 (29.3)	1 (0.7)	1 (0.7)	1 (0.7)	0 (0.0)	44 (31.4)	96 (68.6)
29 – 34	51	14 (27.5)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	15 (29.4)	36 (70.6)
35 – 40	7	2 (28.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (28.6)	5 (71.4)
41 – 46	4	1 (25.0)	2 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (75.0)	1 (25.0)
Total	300	92 (30.7)	7 (2.3)	2 (0.7)	2 (0.7)	0 (0.0)	103 (34.3)	197 (65.7)

χ^2_{4df} (Age Group and % *P. falciparum*) = 1.76, P= 0.780 (P>0.05)
χ^2_{4df} (Age Group and % Total *Plasmodium* infection) = 37.68, P= 0.000 (P<0.05)

Inference

- No significant association between Age groups and % *P. falciparum*(P>0.05)
- Total *Plasmodium* infection is significantly associated with age group (P<0.05)

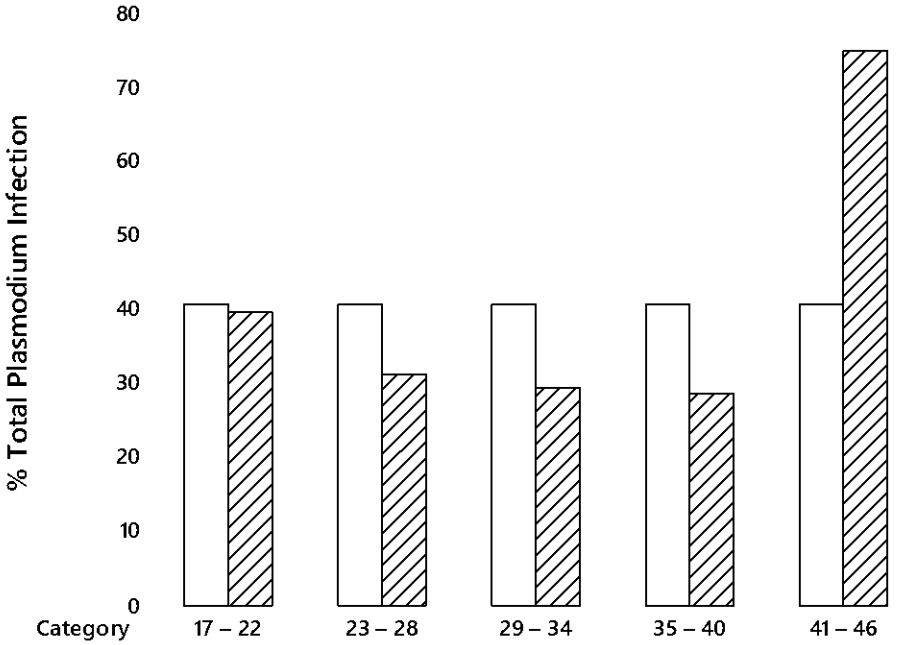

Figure 3: Percentage Total *Plasmodium* Infection Based on Age Groups

Note:Higher observed than expected value = **Age Group 41-46 years**

Table 4: Infection Rates of *Plasmodium* Species Among Pregnant Women Attending Antenatal Clinics in Selected Primary Health Care (PHC) Facilities Across Benue State in Respect to Educational Background

Level Education	No of Total Examined	No positive with *P. falciparum* (%)	No positive with *P. malariae* (%)	No positive with *P. ovale*(%)	No positive with *P. knowlesi* (%)	No positive with *P. vivax* (%)	Total No of Positive (%)	No Negative (%)
Informal education	90	39 (43.3)	4 (4.4)	1 (1.1)	2 (2.2)	0 (0.0)	46 (51.1)	44 (48.9)
Primary education	140	34 (24.3)	2 (1.4)	1 (0.7)	0 (0.0)	0 (0.0)	37 (26.4)	103 (73.6)
Secondary education	50	14 (28.0)	1 (2.0)	0 (0.0)	0 (0.0)	0 (0.0)	15 (30.0)	35 (70.0)
Tertiary education	20	5 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (25.0)	15 (75.0)
Total	300	92 (30.7)	7 (2.3)	2 (0.7)	2 (0.7)	0 (0.0)	103 (34.3)	197 (65.7)

χ^2_{3df} (Educational Background and % *P. falciparum*) = 7.90, P= 0.048 (P<0.05)
χ^2_{3df} (Educational Background and % Total *Plasmodium* infection) = 13.41, P= 0.004 (P<0.05)

Inference

- *Plasmodiumfalciparum* infection is significantly associated with educational background (P<0.05)
- Total *Plasmodium* infection is significantly associated with educational background (P<0.05)

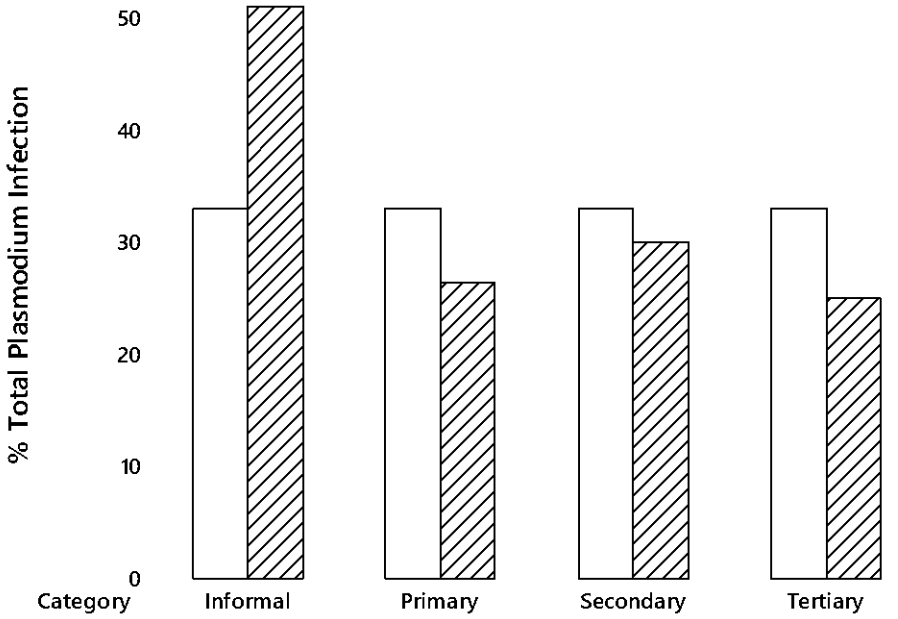

Figure 4: Percentage Total *Plasmodium* Infection Based on Educational Background

Note: Higher observed than expected value = **Informal education**

Table 5: Infection Rates of *Plasmodium* Species Among Pregnant Women Attending Antenatal Clinics in Selected Primary Health Care (PHC) Facilities Across Benue State in Respect to Occupation

Occupation	No of Total Examined	No positive with *P. falciparum* (%)	No positive with *P. malariae* (%)	No positive with *P. ovale*(%)	No positive with *P. knowlesi* (%)	No positive with *P. vivax* (%)	Total No of Positive (%)	No Negative (%)
Farmers	139	47 (33.8)	4 (2.9)	0 (0.0)	2 (1.4)	0 (0.0)	53 (38.1)	86 (61.9)
Traders	73	22 (30.1)	1 (1.4)	2 (2.7)	0 (0.0)	0 (0.0)	25 (34.2)	48 (65.8)
Students	39	12 (30.8)	1 (2.6)	0 (0.0)	0 (0.0)	0 (0.0)	13 (33.3)	26 (66.7)
Housewives	30	7 (23.3)	1 (3.3)	0 (0.0)	0 (0.0)	0 (0.0)	8 (26.7)	22 (73.3)
Professionals	19	4 (21.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (21.1)	15 (78.9)
Total	300	92 (30.7)	7 (2.3)	2 (0.6)	2 (0.6)	0 (0.0)	103 (34.3)	197 (65.7)

χ^2_{4df} (Occupation and % *P. falciparum*) = 4.15, P= 0.386 (P>0.05)
χ^2_{4df} (Occupation and % Total *Plasmodium* infection) = 5.93, P= 0.204 (P>0.05)

Inference

- No significant association between Occupation and % *P. falciparum*(P>0.05)
- No significant association between Occupation and % Total *Plasmodium* infection (P>0.05)

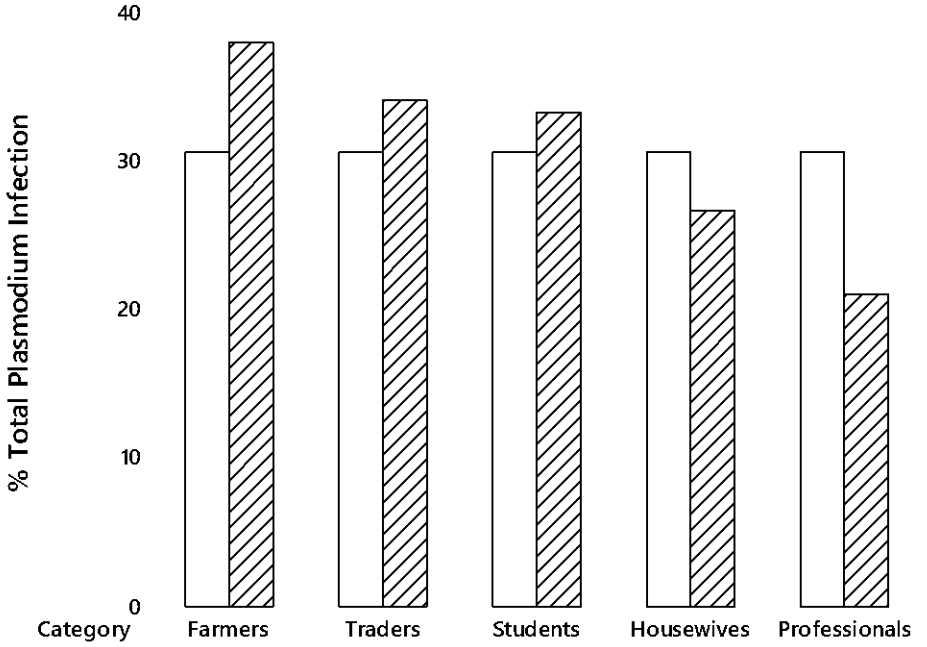

Figure 5: Percentage Total *Plasmodium* Infection Based on Occupation

Note: Higher observed than expected value = **Farmers, Traders and Students**

4. Discussion

The infection rate data across locations in Benue State indicate substantial variability, with higher rates in rural areas like Katsina-Ala (50%) and Vandeikya (35.5%). This aligns with findings from [9], who reported similar rates in Vandeikya, potentially due to a higher presence of mosquito breeding sites and limited healthcare access in these rural areas. These differences reflect regional vulnerabilities, with rural populations facing greater risks of malaria transmission compared to urban areas.

Infection rates were significantly higher among women residing in rural areas (39.3%) than those in urban areas (23.4%), suggesting that rural environments in Benue State may support more favorable mosquito breeding conditions and exposure to Plasmodium species [10, 11]. Additionally, the increased access to preventive resources in urban areas likely contributes to reducing infection rates among urban residents.

Younger pregnant women, particularly those aged 17-22, demonstrated a higher prevalence of malaria infection (39.7%). This observation may be attributed to factors like lower immunity levels and limited prior exposure to malaria, which aligns with findings by [12] in Sokoto State, where higher infection rates were observed among younger women. These age-related vulnerabilities underscore the need for targeted interventions focusing on younger age groups, who are at elevated risk.

Pregnant women with informal education exhibited the highest infection rate (51.1%), underscoring the role of education in malaria prevention. Lower educational levels correlate with reduced awareness and utilization of preventive measures, supported by findings from [13], who indicated that education significantly impacts infection rates. This suggests that improving education about malaria prevention could help reduce infection risks, especially among women with lower educational attainment.

High infection rates among farmers (61.8%) and traders suggest that occupational exposure is a significant factor, as these jobs often involve prolonged time outdoors and increased mosquito contact. [14] observed that occupation influences malaria prevalence among pregnant women in Benue State. The nature of these occupations may limit access to preventive practices like insecticide-treated nets and repellents, further elevating infection risks.

5. Conclusion

This research found that infection rates are particularly higher among women in rural areas, those with lower levels of education, and women in certain occupations such as farming, likely due to increased exposure to mosquito breeding grounds. Younger age groups also show higher infection rates, pointing to potential gaps in immunity and awareness among younger pregnant women.

The study underscores the critical role of preventive measures, such as the use of insecticide-treated nets (ITNs) and intermittent preventive treatment (IPT) in mitigating malaria risks. However, limited access to these preventive tools in some regions may be contributing to persistently high infection rates. Additionally, diagnostic challenges, especially in primary health care settings, may hinder accurate and timely detection,

leading to underreporting and inadequate management of malaria in pregnancy. This study emphasizes the urgent need for targeted malaria control strategies in Benue State. Enhancing access to preventive interventions, improving diagnostic capacity in primary health centers, and increasing awareness, particularly among rural and vulnerable populations, could significantly reduce malaria incidence and associated complications in pregnant women.

Declarations

Ethical Approval and Consent to Participate:

Ethical clearance was obtained from the Department of Zoology and the Primary Health Management Board of Benue State. Pre-survey visits were made to each facility to secure permission from the management teams and introduce the study objectives. Before data collection, both verbal and written informed consent were obtained from all participants. The research was conducted in full compliance with ethical standards and transparency throughout the study process.

Consent for Publication:

All authors consent to the publication of this manuscript and confirm that the work is original, has not been published elsewhere, and is not under consideration for publication elsewhere.

Competing Interests:

The authors declare no competing interests related to this study.

Funding:

This study did not receive any specific funding.

Data Availability:

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' Contributions:

Abakpa Regina E, Abah Emmanuel A: Conceptualization, methodology, and manuscript drafting.

Abah Emmanuel A: Data collection, analysis, and figure preparation.

Ugwu Veronica, Abah Emmanuel A, Ejeh Augustine, Abakpa Regina: Literature review and critical manuscript revision.

All authors read and approved the final manuscript

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