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Original Research Article

Asymptomatic Malaria Parasitaemia and Associated Risk Factors, in Selected Health Facilities within Jos, Plateau State, Nigeria

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Abstract: Malaria continues to remain a serious public health problem, especially in sub-Saharan Africa. Despite substantial investment in malaria control, asymptomatic infections continue to hinder elimination efforts in Nigeria. Individuals with asymptomatic malaria parasitaemia carry transmissible parasites without showing symptoms and therefore remain undetected by routine surveillance. This study aimed to determine the prevalence and risk factors of asymptomatic malaria infection in selected health facilities in Jos, Plateau State, Nigeria. A cross-sectional survey was conducted among 400 apparently healthy participants attending five health facilities: Jos University Teaching Hospital (JUTH), Plateau State Specialist Hospital (PSSH), Bingham University Teaching Hospital (BHUTH), Comprehensive Health Centre (CHC) Dadin Kowa, and Vom Christian Hospital (VCH). Blood samples were examined for malaria parasites by Giemsa-stained thick and thin films under light microscopy, and parasite density was estimated per microliter of blood. Demographic and behavioural data were obtained through structured questionnaires. Statistical analyses were performed using the chi-square test and bivariate logistic regression to determine associations among asymptomatic malaria, demographic variables, and potential risk factors. The overall prevalence of asymptomatic malaria was 19.5% (78) by microscopy, varying across facilities from 11.2% to 30.0%. Males showed significantly higher infection (26%) than females (15.7%). Low parasite density (<1,000 parasites/µL) dominated (41%), although 24.4% of infected individuals exhibited high parasitaemia despite being asymptomatic. Occupation was significantly ($P < 0.05$) associated with infection status. Use of insecticide-treated nets (ITNs) did not show significant protective effect ($p > 0.05$), as infection was still common among regular users (19.3%). These findings underscore the substantial reservoir of silent carriers that may sustain malaria transmission in Jos and similar endemic regions. Strengthened surveillance and inclusion of molecular diagnostics in control programs are recommended to detect and treat these hidden infections.

Keywords: Asymptomatic malaria, Jos, Plateau State, Microscopy, Prevalence.

INTRODUCTION

Malaria remains one of the leading public health challenges in sub-Saharan Africa, with Nigeria accounting for a large share of the global burden. In 2023, the World Health Organization (WHO) estimated 263 million malaria cases and 597,000 deaths globally, with sub-Saharan Africa contributing over 94% of the total (1). Despite major control investments, elimination progress has stagnated, largely due to diagnostic and surveillance gaps, and growing resistance to insecticides and antimalarial drugs.

Asymptomatic malaria which is defined as the presence of asexual *Plasmodium* parasites in peripheral blood in the absence of clinical symptoms, is now recognised as a major obstacle to malaria control and elimination. Asymptomatic infections often occur at low parasite densities (frequently submicroscopic by light microscopy) and may persist for weeks to months, creating a hidden reservoir that sustains local

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transmission even where symptomatic cases are declining [2].

Globally, progress against malaria has been uneven: while several countries have markedly reduced clinical case counts and some have achieved elimination, much of sub-Saharan Africa and other endemic regions continue to carry a high burden, and asymptomatic and submicroscopic infections limit the effectiveness of passive case detection strategies. These silent infections evade routine diagnostics and therefore remain untreated, undermining surveillance and elimination campaigns [1].

A growing body of epidemiological and molecular studies demonstrates that the proportion of infections detectable only by sensitive nucleic-acid methods (PCR/PET-PCR) can be substantial, particularly in populations with partial immunity or where control measures have reduced symptomatic incidence. Submicroscopic infections have been implicated in onward transmission because they can produce gametocytes infectious to mosquitoes, so their identification and management are critical for targeted interventions in both high- and low-transmission settings [2].

Recent systematic reviews and observational cohorts show considerable geographic and age-related heterogeneity in the prevalence of asymptomatic and submicroscopic carriage, with implications for intervention design (for example, mass drug administration, focal screening and treatment, or more sensitive surveillance using molecular diagnostics). Incorporating strategies to detect and clear these reservoirs, tailored to local transmission dynamics and resource availability is now considered essential for accelerating progress towards elimination [3].

In Nigeria, a country which continues to account for a large share of global malaria cases, facility- and community-based studies have repeatedly documented substantial rates of asymptomatic parasitaemia, especially in urban and peri-urban centres. Recent molecular surveys in Nigerian settings have confirmed the circulation of diverse *Plasmodium* species and a sizeable submicroscopic burden, reinforcing the need to adapt molecular diagnostic and surveillance approaches to local epidemiology. These findings motivate facility-based investigations in Plateau State, a region with marked seasonal transmission and heterogeneous micro-epidemiology, where the prevalence, demographic distribution and seasonal patterns of asymptomatic infection remain incompletely characterized [4].

Given the public-health importance of asymptomatic parasitaemia as a silent reservoir for malaria transmission, and the limited facility-based data from Jos Plateau State, this study therefore sought to determine the prevalence and determinants of asymptomatic malaria infection in selected health facilities in Jos. The findings are expected to provide scientific evidence necessary for designing targeted interventions that address this neglected component of malaria epidemiology.

MATERIALS AND METHODS

Study Area:

The study was conducted in Jos, Plateau State, North-Central Nigeria. Five health facilities were selected to represent different locations and populations: Jos University Teaching Hospital (JUTH), Plateau State Specialist Hospital (PSSH), Vom Christian Hospital (VCH), Bingham University Teaching Hospital (BHUTH), and Comprehensive Health Centre, Dadin Kowa (CHC).

Jos is characterized by a temperate climate with distinct wet (May–October) and dry (November–April) seasons. The region lies between latitude 9°52’N and longitude 8°54’E, at an elevation of approximately 1,200 meters above sea level, creating favorable conditions for malaria transmission year-round.

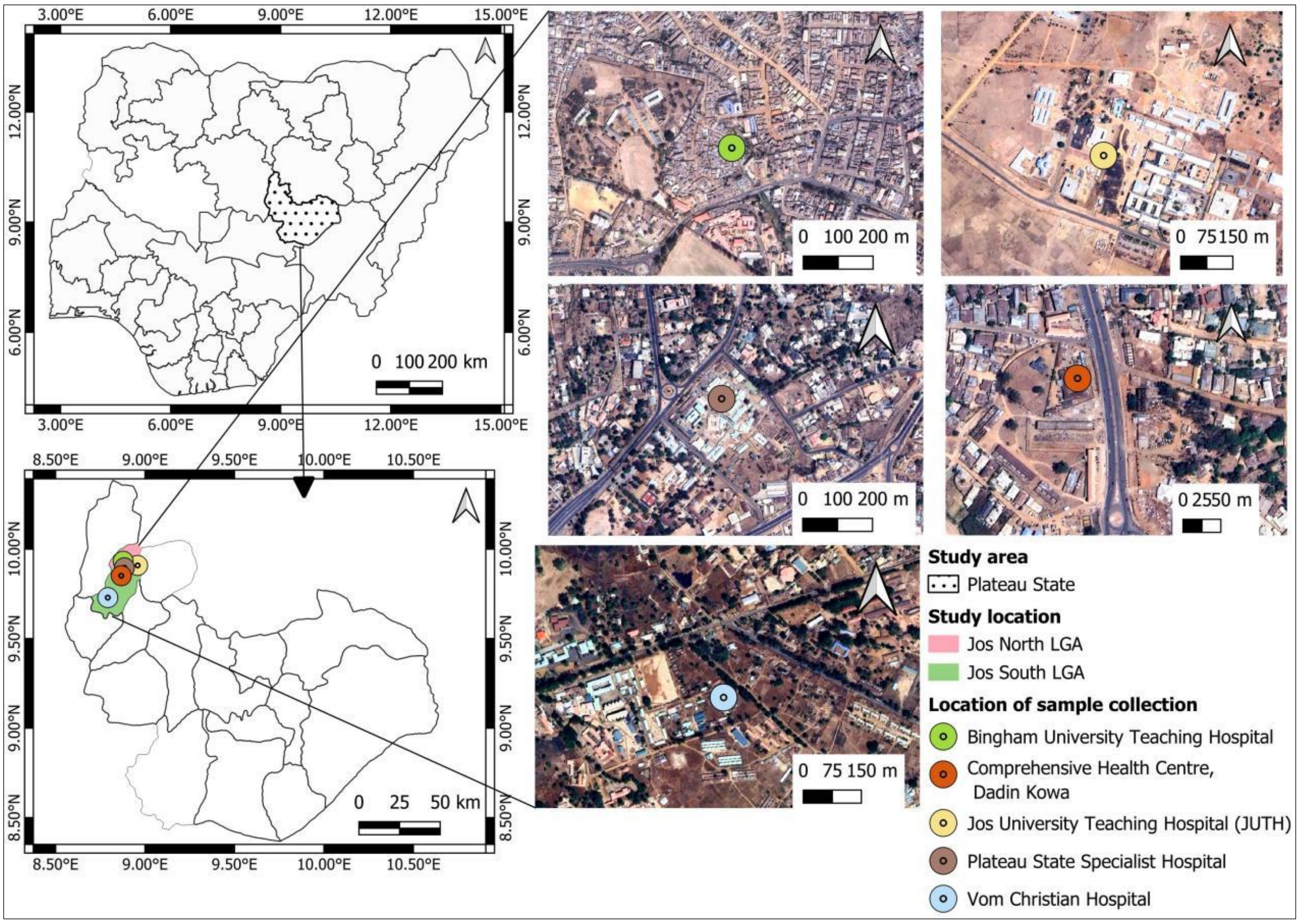

Figure 1: Map of Nigeria showing Plateau State and location of the Sampled Hospitals (Generated using QGIS version 3.40).
Source: Authors Construct, 2024

Ethical Considerations:

Ethical approvals for the study were duly obtained from Plateau State Ministry of Health and the respective research ethics committees of the selected health institutions. Written informed consent was obtained from all participants or their guardians prior to enrollment. Confidentiality was strictly maintained.

Sample Size Determination:

The sample size for this study was determined using the Raosoft® sample size calculator, a widely accepted tool for estimating adequate sample sizes for surveys [5]. A confidence level of 95% and 5% margin of error was used as parameters. This gave a minimum sample size (n) of 384, this was increased to 400 to cover dropouts and to have an even distribution of samples collected from all the selected health facilities.

Study Design and Population:

A cross-sectional study was conducted between January and December, encompassing both dry and wet seasons. Four hundred (400) asymptomatic individuals attending outpatient clinics were recruited.

Eligibility Criteria

Eligibility for participation was based on specific inclusion criteria. Individuals aged six months and above (≥6 months) were considered for inclusion in the survey. The study population included children, pregnant women and adults (non-pregnant women and males) with axillary temperature ≤ 37.5°c, who were not exhibiting any clinical signs or symptoms of malaria at the time of recruitment and who had not received any form of malaria treatment within two weeks prior to data collection. Exclusion criteria involved those showing signs and symptoms of malaria and those who were presently on treatment for malaria or had treated recently.

Structured questionnaires were used to collect socio-demographic data, occupation, education level, mosquito net use, and other relevant risk factors.

Sample Collection and Laboratory Analysis:

Venous blood samples (3 mL) were collected aseptically into EDTA tubes. Thick and thin blood smears were prepared, stained with Giemsa, and examined microscopically for malaria parasites following WHO guidelines. Parasite density was determined by counting asexual parasites against 200 white blood cells (WBCs), assuming a standard WBC count of 8,000/µL.

Statistical Analysis:

Data were analyzed using SPSS version 20 software. Descriptive statistics summarized socio-demographic characteristics and infection prevalence. Associations between categorical variables were assessed using Chi-square and logistic regression tests. Significance was established at $p < 0.05$.

RESULTS

Socio-Demographic Characteristics of the Respondents

A total of 400 respondents were studied. The age distribution showed that the majority of participants were adults between the age of 21–30 years (35.5%) and 31–40 years age group (18.75%) respectively, while children between the ages of 6-10years, constituted the smallest proportion (6%). Females represented a higher proportion of the respondents (63.5%) compared to males (36.5%). In terms of blood group distribution, O+ was the most common (40.5%S), while AB- (1.25%) was the least represented. Regarding genotype, a significant majority had the AA genotype (67.25%), followed by AS (30%) and a small proportion of SS (2.75%), a finding relevant to malaria pathophysiology (Table 1).

Table 1: Socio-demographic Characteristics of the Respondents

Characteristics	Frequency (n)	Percentage (%)
AGE (in years)		
1-5	34	8.5
6-10	24	6
11-20	73	18.25
21-30	141	35.25
31-40	75	18.75
41 and above	53	13.25
SEX		
Male	146	36.5
Female	254	63.5
BLOOD GROUP		
A+	90	22.5
A-	14	3.5
B+	74	18.5
B-	5	1.25
AB+	41	10.25
AB-	5	1.25
O+	162	40.5
O-	9	2.25
GENOTYPE		
AA	269	67.25
AS	120	30
SS	11	2.75
MARITAL STATUS		
Single	228	57
Married	172	43
OCCUPATION		
Job holder(employed)	56	14
Labourer	44	11
Business	163	40.75
Others	137	34.25
EDUCATIONAL STATUS		
Non-formal education	14	3.5
Primary	58	14.5
Secondary	120	30
Higher institution	208	52

N=400

Asymptomatic Malaria Infection and Associated Risk Factors

From the bivariate logistic regression analysis, no statistically significant associations were observed between blood group and infection status ($p > 0.05$). Across the different genotypes sampled, although individuals with genotype SS had the highest infection prevalence (45.5%), the association was not statistically significant ($p > 0.05$). Marital status was not significantly associated with infection ($p = 0.664$), as singles (OR = 1.125, 95% CI: 0.66–1.92) had higher odds of infection compared to married individuals. Occupation was significantly associated with infection status. Participants who were employed (OR = 0.469, 95% CI: 0.23–0.98, $p = 0.044$), business persons (OR = 0.169, 95% CI: 0.05–0.58, $p = 0.005$), and labourers (OR = 0.338, 95% CI: 0.16–0.73, $p = 0.005$) had significantly lower odds of infection compared to those in the "Others" category. Educational level also showed no significant association with infection status ($p > 0.05$). There was also no significant association between mosquito net usage, frequency of usage and malaria infection status (Table 2).

Table 2: Asymptomatic Malaria Infection and Associated Risk Factors

Risk factor	No. Examined (n=400)	No. Infected (%)	Odds Ration	95% CI	*P*-value
Blood group					
O-	9	0 (0.0)			
O+	162	31 (19.1)	0.983	0.46-2.10	0.964
B+	74	13 (17.6)	1.465	0.76-2.81	0.250
A+	90	23 (25.6)	0.485	0.10-2.44	0.380
A-	14	2 (14.3)	0.765	0.29-2.01	0.585
AB+	41	7(17.1)	1.207	0.12-12.06	0.873
AB-	5	1 (20.0)	1.029	0.11-9.95	0.980
B-	5	1 (20.0)	0.000	0.00-0.00	0.999
Genotype					
SS	11	5 (45.5)			
AA	269	51 (19.0)	0.998	0.56-1.79	0.996
AS	120	22 (18.3)	2.900	0.75-11.26	0.124
Marital Status					
Married	172	34 (19.8)			
Single	228	44 (19.3)	1.125	0.66-1.92	0.664
Occupation					
Others	137	23 (16.8)			
Employed	56	18 (32.1)	0.469	0.23-0.98	0.044
Business man/Woman	163	33 (20.2)	0.169	0.05-0.58	0.005
Labourer	44	4 (9.1)	0.338	0.16-0.73	0.005
Level of Education					
Non-formal education	14	0 (0.0)			
High Institution	208	43 (20.7)	0.750	0.41-1.38	
Secondary School	120	21 (17.5)	1.343	0.64-2.81	
Primary school	58	14 (24.1)	0.000	0.00-0.00	
Do you sleep under mosquito treated net?					
Yes	244	47 (19.3)			
No	156	31 (19.9)			
How often do you sleep under mosquito treated net?					
Three times a week	46	4 (8.7)			
Every day	223	42 (18.8)	1.722	0.91-3.25	0.094
Once a week	88	22 (25.0)	1.397	0.60-3.24	0.436
Twice a week	43	10 (23.3)	0.430	0.14-1.32	0.140

Prevalence of Asymptomatic Malaria Infection across Selected Health Facilities

Out of the 400 asymptomatic participants examined, 78 (19.5%) were positive for malaria parasites by microscopy (Table 3). Prevalence varied across health facilities, with the highest recorded at Vom Christian Hospital (30.0%) and the lowest at Jos University Teaching Hospital (11.2%).

Table 3: Prevalence of Asymptomatic Malaria Infection across Some Selected Health Facilities in Jos, Plateau State, Nigeria confirmed by Microscopy

Location	No. examined	No. infected	Percentage infected (%)
BHUTH	80	16	20.0
CHC, Dadin Kowa	80	14	17.5
JUTH	80	9	11.2
PSSH	80	15	18.8
VCH	80	24	30.0
Total	400	78	19.5

χ^2=9.333, df=4, p=0.053

Note: BHUTH = Bingham University Teaching Hospital = CHC, Dadin Kowa (Comprehensive Health Center, Dadin Kowa); JUTH=Jos University Teaching Hospital; PSSH = Plateau State Specialist Hospital; VCH = Vom Christian Hospital

Prevalence of Asymptomatic Malaria Infection by Category

The sampled population was grouped into demographic category (Figure 1). Across these categories, asymptomatic malaria infection although did not differ significantly (p>0.05), however, adult males accounted for the highest burden of the infection (25%) followed by adult females (21%). In the children and pregnant women, the prevalence recorded was 21% and 11% respectively.

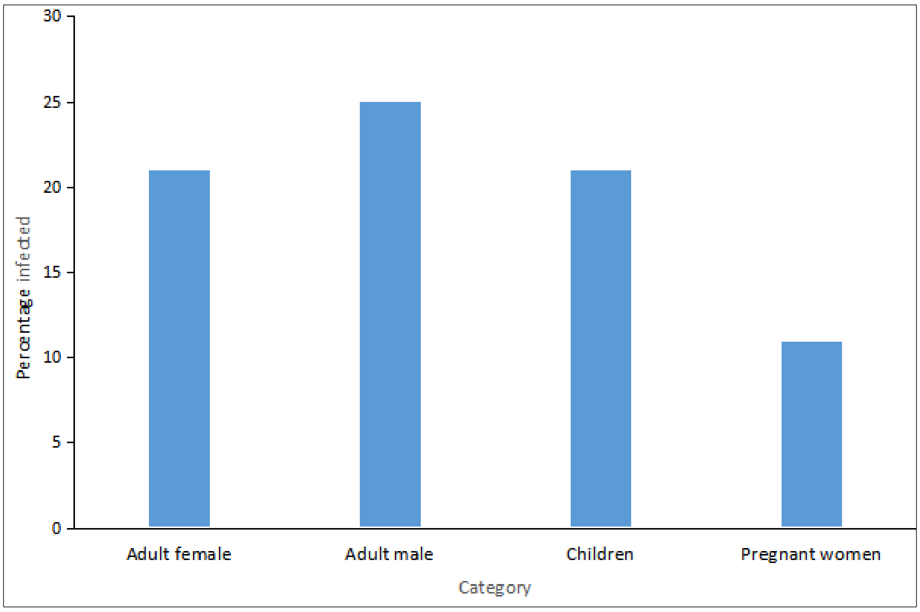

Figure 1: Prevalence of Asymptomatic Malaria Infection by Category

χ^2=6.816, df=3, p<0.078

Prevalence of Asymptomatic Malaria Infection in Relation to Sex and Age of Respondents

The prevalence of asymptomatic malaria was significantly higher in males (26.0%) than in females (15.7%) (p = 0.012) (Table 4). Across age groups, infection was highest among children aged 1–5 years (20.6%) and 11–20 years (20.5%), with no significant difference across age groups (p > 0.05) (Table 5).

Table 4: Prevalence of Asymptomatic Malaria Infection in Relation to Sex of Respondents confirmed by Microscopy

Sex	No. examined	No. infected	Percentage infected (%)
Female	254	40	15.7
Male	146	38	26.0
Total	400	78	19.5

χ^2=6.241, df=1, p=0.012

Table 5: Prevalence of Asymptomatic Malaria Infection in Relation to Age Group of Respondents confirmed by Microscopy

Age group	No. examined	No. infected	Percentage infected (%)
1-5 years	34	7	20.6
6-10 years	24	4	16.7
11-20 years	73	15	20.5
21-30 years	141	28	19.9
31-40 years	75	15	20.0
41 years and above	53	9	17.0
Total	400	78	19.5

$\chi^2 = 0.437$, df=5, p=0.994

Parasite Density in Asymptomatic Malaria Infections among Respondents

Parasite density among asymptomatic individuals ranged from 100 to over 10,000 parasites/µL. Mild infections (<1,000 parasites/µL) predominated (41%), followed by moderate (34.6%) and high (24.4%) parasitaemia. This indicates that most asymptomatic carriers had low-level parasitaemia, but a subset of individuals harbored high-density infections capable of sustaining transmission despite being asymptomatic (Figure 2).

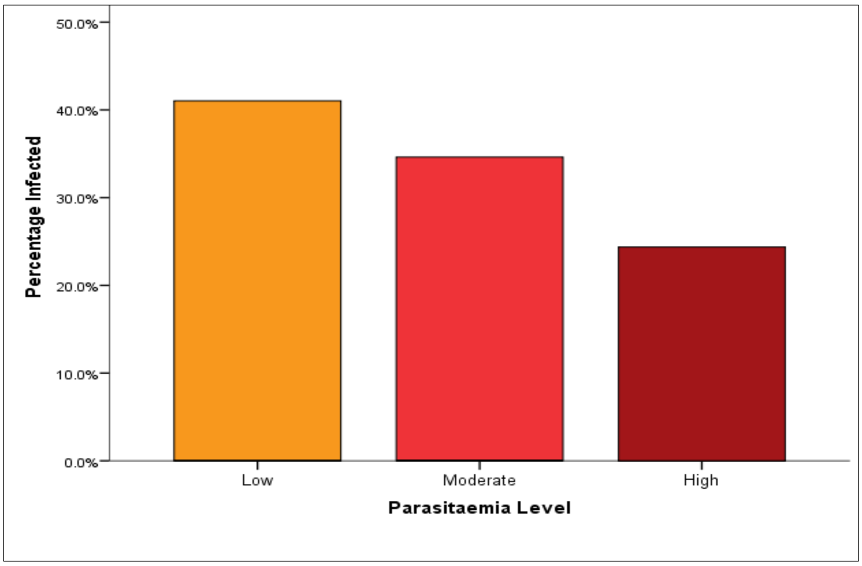

Figure 2: Parasite Density of Asymptomatic Malaria Infections in Some Selected Health Facilities within Jos, Plateau State, confirmed by Microscopy

Note: Low (1-999 parasites/µL); Moderate (1000-9999 parasites/µL); High (≥10000 parasites/µL)

DISCUSSION

The present study in selected health facilities within Jos, Plateau State (Nigeria) found an overall microscopy-based prevalence of asymptomatic malaria of 19.5 % (78/400) among apparently healthy individuals. This prevalence is consistent with, and in some cases somewhat lower than, estimates reported in other Nigerian settings, but nonetheless confirms that a substantial silent reservoir of infection persists in this endemic area, with implications for malaria-control and elimination efforts. For example, a population survey in Ido-Ekiti recorded a 19.0% microscopy prevalence among asymptomatic adults (6), which is similar to the result gotten in this study. Likewise, a cross-sectional study in Makurdi, Benue State reported a microscopy prevalence of 28.1% among apparently healthy individuals [7]. These figures reinforce that ~20-30 % prevalence in asymptomatic populations is not uncommon in Nigeria. On the other hand, other Nigerian studies have reported even higher prevalence: for example, in a suburban population of Lagos, microscopy detected 24.7 % and qPCR 35.4 % of asymptomatic malaria infections [8]. Meanwhile, a much lower prevalence of 4.8 % was reported from a community-based survey in Ethiopia [9]. These variations reflect differences in transmission intensity, seasonality, diagnostic sensitivity and study populations.

In this study, males had the highest (26%) prevalence of asymptomatic malaria infection compared to females (15.7%). This adds to literature that often shows gender differences in malaria infection risk, potentially due to behavioural, occupational or exposure differences. There was no statistically significant difference across age groups ($p > 0.05$), though the highest prevalence was in children aged 1-5 years (20.6 %) and 11-20 years (20.5 %). This suggests that in this setting, partial immunity may not fully suppress parasite carriage in older groups, or that exposure remains fairly uniform across age strata. This aligns with the findings from a study in Northern Uganda where prevalence was disproportionately higher in children 5-10 years (45.9%), followed by those between the ages of 10-15 years (30.6%) (10). Simlarly, a study in Lagos showed that school-age children (6-14 years) had highest prevalence (8). Several studies elsewhere have predicted similar higher prevalence of malaria burden among older age groups above 5 years following reduced transmission due to impact of control interventions [11]. The absence of strong age-trend in this study, may reflect the facility-based nature, heterogeneity of exposure, or that asymptomatic carriage persists across all ages.

Occupation was significantly associated with infection risk, with those in the "Others" category (likely informal or high-exposure occupations) exhibiting higher prevalence. This mirrors findings in various studies where informal workers or those with outdoor occupational exposure had greater malaria risk (e.g. rural-agriculture, casual labour). Socio-economic status and occupation have been repeatedly found to affect exposure and protective measure access. Interestingly, the use of mosquito nets did not show a statistically significant association with reduced infection, and no trend was seen with frequency of use. This finding contradicts some studies: e.g., in a study in Nsukka, Enugu State, Nigeria, school-age children showed a significantly lower prevalence of asymptomatic malaria when they slept under LLINs ($p = 0.024$) [12]. This also contradicts earlier findings by WHO (13), which strongly advocate ITN use as a frontline preventive measure. The disparity may arise from inconsistent net use, poor net condition, low insecticide effectiveness, or insecticide resistance in local vector populations.

Asymptomatic malaria infections are often characterised by low parasite densities, which makes detection challenging and this contributes to sustained transmission. In the present study, among infected individuals, low parasite densities (<1,000 parasites/µL) predominated (41 %), but a meaningful proportion (24.4 %) had high parasitaemia (≥10,000 parasites/µL) despite being asymptomatic. This is a notable finding, as higher parasite densities in asymptomatic cases have been associated with increased odds of developing symptomatic malaria [10]. The presence of moderate to high density infections in asymptomatic individuals also means that reliance on symptomatic case detection will miss a part of the transmission chain. This further emphasizes the importance of parasite density estimation and treatment of asymptomatic cases.

CONCLUSION

In summary, this study confirms that asymptomatic malaria infection constitutes a major hidden burden in Jos, Plateau State, Nigeria. The prevalence (~19.5 %) and parasite density distribution (including a substantial high-density subset) reinforce the notion that silent carriers may sustain transmission even in the absence of clinical illness. Risk factor analysis underscores the role of occupation and the need to re-assess ITN effectiveness under local conditions. For malaria control and elimination strategies to succeed, efforts must expand beyond symptomatic case detection to active surveillance, molecular diagnostics and tailored vector control. Continued research and monitoring of asymptomatic carriage across seasons, using a combination of microscopy and molecular methods, will be critical for the region’s malaria elimination agenda.

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