

Prevalence and Risk Factors for Plasmodium Falciparum Malaria among Pregnant Women Attending the Antenatal Clinic at Bor State Hospital, South Sudan

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Abstract

Malaria in pregnancy is still a major public health problem in sub-Saharan Africa with little locally generated evidence from South Sudan. The purpose of this study was to determine the prevalence of *Plasmodium falciparum* malaria and associated factors among pregnant women attending antenatal care at Bor State Hospital, South Sudan.

An analytical cross-sectional study was conducted on 249 pregnant women in a hospital. Data were collected by using a standardized questionnaire, laboratory diagnosis form, and clinical record sheet presented by an interviewer. Malaria infection was identified utilizing a histidine-rich protein-2 quick diagnostic test and microscopy of Giemsa-stained thick and thin films, with microscopy as the reference diagnostic method. Data were analyzed using SPSS version 26. Bivariate analyses were done to identify variables for multivariable binary logistic regression, and adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were given. Statistical significance was set at $p < 0.05$.

Of the 249 women, 107 were positive for malaria, giving a prevalence rate of 42.9% (95% CI 37.0–49.2%). The highest prevalence was observed among women less than 20 years old (66.7%), women with little formal education (54.3%), farmers (58.1%), women who lived in rural regions (48.9%), primigravidae (55.8%), and those who attended ANC just one to three times (52.9%). Multivariable analysis showed that no formal education (AOR 6.85, 95% CI 1.47–31.91), primary education (AOR 6.12, 95% CI 1.33–28.15), rural residence (AOR 2.29, 95% CI 1.13–4.64), primigravidity (AOR 5.65, 95% CI 2.37–13.47) and one to three ANC visits (AOR 7.00, 95% CI 1.88–26.01) were associated with increased odds of malaria. However, use of long-lasting insecticidal nets (LLINs) (AOR 0.41, 95% CI 0.19–0.89) and uptake of intermittent preventive treatment in pregnancy (IPTp) (AOR 0.38, 95% CI 0.19–0.76) were linked with decreased odds of infection.

Malaria prevalence among pregnant women attending Bor State Hospital was very high. It is important to improve ANC attendance, access and usage of LLINs, delivery of IPTp, and targeted health education for women with inadequate educational backgrounds and those who reside in remote areas to help minimize malaria infection during pregnancy.

Background

Malaria remains a major public health problem in sub-Saharan Africa, where intense and stable transmission of *Plasmodium falciparum* occurs in many settings [1]. Pregnancy induces susceptibility to malaria by immunological changes and by sequestration of infected erythrocytes in the placenta. Malaria in pregnancy is associated with maternal anemia and adverse fetal and neonatal outcomes such as fetal growth restriction, low birth weight, stillbirth, and maternal or neonatal death [2, 3].

South Sudan has a high burden of malaria, while conflict, population displacement, and weaknesses in the health system can limit access to prevention, diagnosis, and treatment services [5, 6]. Previous evidence from South Sudan has documented malaria among pregnant women, but there is limited

facility-specific evidence from Jonglei State and particularly among women attending antenatal care at Bor State Hospital [5, 6].

In sub-Saharan Africa, young maternal age, primigravidity, low educational attainment, rural residence, inadequate antenatal care attendance, and suboptimal use of malaria prevention measures have been associated with malaria during pregnancy [8, 9]. Interventions that have proven efficacy include long-lasting insecticidal nets (LLINs), intermittent preventive treatment during pregnancy with sulfadoxine-pyrimethamine (IPTp-SP), indoor residual spraying (IRS), and early diagnosis and effective treatment [4, 9].

Bor State Hospital is the main public referral hospital in Jonglei State, and provides antenatal, laboratory, maternity and other referral services. The hospital serves women from Bor and surrounding areas including rural communities. However, the local burden and determinants of *P. falciparum* infection among pregnant women attending its antenatal clinic were not adequately documented. This study was carried out to assess the prevalence of *P. falciparum* malaria and to explore the socio-demographic, obstetric and malaria-prevention factors associated with malaria infection among pregnant women attending antenatal care at Bor State Hospital.

Study objective

The objective was to determine the prevalence of *Plasmodium falciparum* malaria and its associated risk factors among pregnant women attending the antenatal clinic at Bor State Hospital, South Sudan.

Specific objectives were to determine malaria prevalence; assess associations with socio-demographic characteristics; assess associations with obstetric characteristics; assess associations with malaria preventive measures; and identify independent predictors of *P. falciparum* infection.

Methods

Study design and setting

The study was an analytical cross-sectional study conducted in a hospital setup at Bor State Hospital in Bor Town, the capital of Jonglei State in South Sudan. The hospital is a public referral facility offering outpatient, inpatient, emergency, surgical, maternity, laboratory, and antenatal care services. The surrounding Bor South County has a tropical climate with a long rainy season from about April to November and a dry season from December to March, conditions conducive to mosquito breeding and perennial malaria transmission.

Study population and eligibility

The study population was the pregnant women who attended the antenatal clinic at Bor State Hospital during the study period. Participation was voluntary, and written informed consent was obtained before enrollment.

Criteria for inclusion: Pregnant women who were willing to participate, attended the antenatal care clinic at Bor State Hospital during the study period, gave informed consent, and were able to provide the required information and blood sample for malaria testing were included in the study. Eligible participants could be included only once in the study period.

Criteria for exclusion included refusal to provide informed consent; being critically ill or in need of urgent medical attention; inability or unwillingness to provide a blood sample for malaria testing; and previous participation in the study during the same pregnancy. Also, participants with insufficient information to assess the primary outcome or key variables were excluded from the final analysis.

Sample size

The sample size was calculated using the single population proportion formula based on the following assumptions: a prevalence of malaria of 50%, a confidence level of 95%, and a margin of error of about 6.2%. The calculation resulted in a target of about 250 participants. The final study sample consisted of 249 pregnant women. Sample-size calculation has been revised to be consistent with the approved study protocol and ethics submission. The 10% non-response adjustment is explicitly presented, and the final sample size is reported accordingly

Data collection

Data were collected using three instruments: a structured questionnaire administered by an interviewer, a laboratory diagnostic form, and a clinical recording sheet. The questionnaire was translated into Dinka and Arabic and included socio-demographic characteristics, obstetric history, antenatal care (ANC) attendance, malaria prevention practices, and selected environmental factors. Interviews were approximately 20–25 minutes in length.

Laboratory diagnosis

The P.P. falciparum infection was diagnosed by a malaria rapid diagnostic test based on histidine-rich protein-2 and microscopy of Giemsa-stained thick and thin blood films. The reference method for diagnosis was established as microscopy. Parasite density was calculated against leukocyte counts, and discordant results were reviewed by a senior laboratory technician. The clinical record sheet included vital signs, pallor, splenomegaly, gestational age, and hemoglobin.

Study variables

The dependent variable was malaria infection status. Independent variables included age, marital status, educational level, occupation, residence, gravidity, parity, trimester, number of ANC visits, LLIN use, IRS use, and IPTp uptake.

Data management and statistical analysis

Data was assigned unique study identification numbers. Paper records were kept securely, and electronic data was password protected. Data were double entered and verified in Microsoft Excel before exporting to SPSS version 26. We used frequencies, percentages, means, and medians as descriptive statistics. The prevalence of malaria was determined as the percentage of women testing positive among all women tested. Chi-square tests and other specified inferential procedures were used for bivariate analyzes. Candidate variables with a $p < 0.20$ were considered for multivariable binary logistic regression. Independent factors were identified using backward stepwise regression, and adjusted odds ratios and 95% CIs are reported. The fit of the model was evaluated with the Hosmer-Lemeshow test, and the multicollinearity was assessed with the variance inflation factor. The significance level was set at $p < 0.05$.

Pretesting and quality assurance

The instruments were pretested on 30 pregnant women who were not included in the main study. Ambiguous and redundant items were changed. Research assistants were trained in study protocol, ethics, and interviewing procedures. The completed questionnaires were reviewed for completeness. Laboratory technicians were blinded to clinical status, and 10% of blood smears were independently re-read for quality control.

Ethical considerations

Participation was voluntary, informed consent was obtained in writing, and confidentiality and anonymity were ensured. Participants diagnosed with malaria were counseled and provided with appropriate treatment through the antenatal clinic following national malaria treatment guidelines. Ethical approval: RERB NO: 67/6/6/2026-MOH/RERB/63/2026. The institutional review board and hospital medical director for Bor State Hospital approved the study to collect data in Bor State Hospital, all participants gave informed consent prior to interviews. All other ethical issues pertaining to the maintenance of confidentiality were strictly adhered to during the study.

Results

Participant characteristics

A total of 249 pregnant women were recruited in the study. The mean age was 26.5 years (SD 6.9), with the majority of participants between 20 and 29 years old (60.2%). Most of the participants were married (66.7%), without formal education (42.2%), unemployed (48.6%), and living in rural areas (71.5%). 45.4% of participants were primigravidae, and 47.0% were primiparae. The largest group of women was in the second trimester of pregnancy (41.0%), and 55.4% reported having one to three antenatal care (ANC) visits. Long-lasting insecticide-treated net (LLIN) usage was 79.9%, indoor residual spraying (IRS) exposure was 65.9%, and intermittent preventive treatment in pregnancy (IPTp) uptake was 63.9%. [Table 1]

Table 1
socio- demographics obstetric, and malaria, prevention
characteristic

Characteristic	Category	n	%
Age group	< 20 years	6	2.4
	20–29 years	150	60.2
	30–39 years	69	27.7
	40–49 years	24	9.6
Marital status	Married	166	66.7
	Single	47	18.9
	Divorced/separated	24	9.6
	Widowed	12	4.8
Education	No education,	105	42.2
	Primary	83	33.3
	Secondary	43	17.3
	Tertiary	18	7.2
Occupation	Unemployed	121	48.6
	Self-employed/business	49	19.7
	Farming	31	12.4
	Civil servant	29	11.6
	Student	19	7.6
Residence	Rural	178	71.5
	Urban	71	28.5
Gravidity	Primigravida	113	45.4
	2–4 pregnancies	85	34.1
	≥ 5 pregnancies	51	20.5
Parity	Primipara	117	47.0
	2–4 live births	74	29.7
	≥ 5 live births	58	23.3
Trimester	First	66	26.5

Characteristic	Category	n	%
	Second	102	41.0
	Third	81	32.5
ANC visits	1–3	138	55.4
	4–6	86	34.5
	≥ 7	25	10.0
LLIN use,	Yes	199	79.9
	No	50	20.1
IRS use	Yes	164	65.9
	No	85	34.1
IPTp uptake	Yes	159	63.9
	No	90	36.1

Prevalence of Plasmodium falciparum malaria

Among the 249 pregnant women tested, 107 (42.9%) tested positive for malaria, while 142 (57.1%) tested negative. The overall prevalence of malaria was 42.9% (95% CI 37.0–49.2%). [Table 2]

Table 2
Overall Prevalence of Plasmodium
falciparum Malaria

Malaria status	N	%
Positive	107	42.9
Negative	142	57.1
Total	249	100.0

Bivariate associations

Prevalence of malaria was significantly different across age, educational level, occupation and residence [Table 3] The highest prevalence was seen in women younger than 20 years (66.7%) and the lowest in women aged 40–49 years (29.2%; $p = 0.034$). The prevalence decreased with increased educational levels from 54.3% in women with no formal education to 11.1% in those with tertiary education ($p < 0.001$). Farmers had the highest prevalence (58.1%) among occupational groups ($p = 0.018$), and rural residents had a higher prevalence than urban residents (48.9% vs. 28.2%; $p = 0.003$). Malaria was not significantly associated with marital status ($p = 0.379$).

Table 3
Bivariate Analysis of Socio-Demographic Factors

Variable	Category	Positive/Total	Prevalence %	p-value
Age	< 20 years	4/6	66.7	0.034
	20–29 years	66/150	44.0	
	30–39 years	30/69	43.5	
	40–49 years	7/24	29.2	
Education	No education	57/105	54.3	< 0.001
	Primary	34/83	41.0	
	Secondary	14/43	32.6	
	Tertiary	2/18	11.1	
Occupation	Unemployed	57/121	47.1	0.018
	Self-employed/business	23/49	46.9	
	Farming	18/31	58.1	
	Civil servant	7/29	24.1	
	Student	2/19	10.5	
Residence	Rural	87/178	48.9	0.003
	Urban	20/71	28.2	

Bivariate Analysis of Obstetric Factors

Malaria was also related to obstetric characteristics [Table 4]. The prevalence was 55.8% in primigravidae, 40.0% in women with 2–4 pregnancies and 19.6% in women with at least five pregnancies ($p < 0.001$). Primiparae had a prevalence of 55.6% as compared to 41.9% in women with 2–4 live births and 19.0% in women with at least five live births ($p < 0.001$). ANC attendance was strongly inversely associated with prevalence of 52.9% in women with 1–3 visits, 36.0% in women with 4–6 visits and 12.0% in women with at least seven visits ($p < 0.001$). Trimester was not significantly associated with malaria ($p = 0.262$).

Table 4
Bivariate Analysis of Obstetric Factors

Variable	Category	Positive/Total	Prevalence %	p-value
Gravidity	Primigravida	63/113	55.8	< 0.001
	2–4 pregnancies	34/85	40.0	
	≥ 5 pregnancies	10/51	19.6	
Parity	Primipara	65/117	55.6	< 0.001
	2–4 live births	31/74	41.9	
	≥ 5 live births	11/58	19.0	
ANC visits	1–3	73/138	52.9	< 0.001
	4–6	31/86	36.0	
	≥ 7	3/25	12.0	

Malaria Prevention Practices

In bivariate analysis, malaria prevention practices were associated with infection [Table 5]. Prevalence was lower among LLIN users compared to non-users (40.2% vs 54.0%; $p = 0.034$). Prevalence was lower among women reporting IRS exposure (39.0% vs 50.6%; $p = 0.043$) and women who had received IPTp (36.5% vs 54.4%; $p = 0.003$).

Table 5
Bivariate Analysis of Malaria Prevention Practices

Variable	Category	Positive/Total	Prevalence %	p-value
LLIN use	Yes	80/199	40.2	0.034
	No	27/50	54.0	
IRS use	Yes	64/164	39.0	0.043
	No	43/85	50.6	
IPTp uptake	Yes	58/159	36.5	0.003
	No	49/90	54.4	

Multivariable analysis

Variables with the above-mentioned screening criterion ($p < 0.20$) were entered into multivariable binary logistic regression. In the final model, educational level, residence, gravidity, ANC visits, LLIN use and IPTp uptake were significantly associated [Table 6]. Women with no formal education had higher odds of malaria than women with tertiary education (AOR 6.85, 95% CI 1.47–31.91; $p = 0.014$) and women with

primary education had higher odds (AOR 6.12, 95% CI 1.33–28.15; $p = 0.020$). Malaria odds were higher among rural residents (AOR 2.29, 95% CI 1.13–4.64; $p = 0.021$). Primigravida (AOR 5.65, 95% CI 2.37–13.47; $p < 0.001$) and 1–3 ANC visits (AOR 7.00, 95% CI 1.88–26.01; $p = 0.004$) were also associated with increased odds. LLIN use (AOR 0.41, 95% CI 0.19–0.89; $p = 0.025$) and IPTp uptake (AOR 0.38, 95% CI 0.19–0.76; $p = 0.006$) were associated with reduced odds of infection. Farming had borderline association (AOR 5.41, 95% CI 1.00–29.18; $p = 0.050$). The Hosmer-Lemeshow test of the model indicated good fit ($\chi^2 = 7.234$, $p = 0.512$) and an overall correct classification rate of 75.5%.

Table 6
Multivariable Logistic Regression Analysis

Variable	Category	AOR (95% CI)	p-value
Education	No education	6.85 (1.47–31.91)	0.014
	Primary	6.12 (1.33–28.15)	0.020
	Secondary	3.78 (0.77–18.61)	0.102
	Tertiary (Ref.)	1.00	–
Residence	Rural	2.29 (1.13–4.64)	0.021
	Urban (Ref.)	1.00	–
Gravidity	Primigravida	5.65 (2.37–13.47)	< 0.001
	2–4 pregnancies	2.76 (1.28–5.96)	0.010
	≥ 5 pregnancies (Ref.)	1.00	–
ANC visits	1–3	7.00 (1.88–26.01)	0.004
	4–6	3.22 (0.85–12.15)	0.085
	≥ 7 (Ref.)	1.00	–
LLIN use	Yes	0.41 (0.19–0.89)	0.025
	No (Ref.)	1.00	–
IPTp uptake	Yes	0.38 (0.19–0.76)	0.006
	No (Ref.)	1.00	–
Occupation	Farming	5.41 (1.00–29.18)	0.050

Discussion

The study revealed a high prevalence of *P. falciparum* malaria among pregnant women attending antenatal care at Bor State Hospital, 42.9% of the 249 women tested were positive. The high burden

among a population attending antenatal services reflects ongoing malaria transmission despite the availability of preventive interventions.

The prevalence observed was higher than the 9.1% prevalence reported in a previous South Sudan study cited in the report [5] and higher than estimates reported across several sub-Saharan African settings [2, 8]. Differences may reflect variation in study populations, transmission intensity, season, diagnostic methods, referral patterns and the particular setting in which participants were recruited. The study population may differ from community-based samples as Bor State Hospital is a referral facility serving urban and rural populations.

Educational attainment was among the strongest independent correlates of infection. Women with no formal education were almost seven times more likely to have malaria than women with tertiary education and women with primary education had much higher odds. Education may influence knowledge of malaria transmission and prevention, early care seeking, attendance at antenatal care and consistent use of preventive interventions. These findings support health education that is targeted, uses accessible language, and employs community-based communication approaches [9, 10].

Rural residence was independently associated with higher odds of malaria infection. In rural settings, this higher burden may be due to environmental exposure, proximity to mosquito breeding sites, outdoor activities, housing conditions, and more limited access to health services and prevention commodities. This finding supports the argument to enhance malaria prevention and ANC outreach in rural communities rather than relying solely on facility-based services.

Gravidity was strongly associated with malaria infection. Primigravidae had > 5 times the odds of infection compared with women with > 5 pregnancies, and women with 2–4 pregnancies also had higher odds. This pattern makes biological sense, as pregnancy-specific immunity to placental malaria is acquired with repeated exposure and first pregnancies are especially susceptible [2, 12, 13].

There was a strong gradient in ANC attendance. Women who had one to three ANC visits were about seven times more likely to have malaria than women who had at least seven visits. Frequent ANC contact provides opportunities for malaria testing, delivery of IPTp, provision of LLINs, health education, and early diagnosis and treatment. Thus, the association supports the efforts to improve early ANC initiation and continuity of care.

LLIN use and IPTp uptake were independently associated with decreased odds of malaria. The use of LLIN was associated with a 59% reduction in the odds of infection and the uptake of IPTp was associated with a 62% reduction. These findings are in line with the preventive role of these interventions in pregnancy [9, 12]. Nevertheless, only 63.9% and 79.9% of participants reported uptake of IPTp and use of LLINs, respectively, indicating gaps in coverage. The report also found that IRS was protective in bivariate analysis, although not independently significant in the multivariable model, suggesting that its apparent effect may have been confounded by other factors.

Strengths of this study include laboratory confirmation by rapid diagnostic testing and microscopy, structured data collection instruments, multivariate analysis and quality-control procedures. However, the cross-sectional design precludes causal inference and no temporal relationships between exposures and infection can be established. Findings may not be generalizable to pregnant women who do not attend ANC or seek care elsewhere as the setting is hospital based. In addition, self-reported prevention practices may be subject to recall or social-desirability bias.

Conclusions

The prevalence of malaria due to *P. falciparum* among pregnant women attending antenatal care at Bor State Hospital was remarkably high (42.9%). Low educational status, rural residence, primigravidity, and fewer ANC visits were associated with increased odds of infection. Conversely, the use of long-lasting insecticidal nets (LLINs) and uptake of intermittent preventive treatment in pregnancy (IPTp) were associated with reduced odds of infection. These findings underscore the need to improve malaria prevention through antenatal services, improve continuity and early commencement of ANC, ensure reliable access to LLINs and IPTp, and tailor health education and outreach to women with low education and women living in rural areas.

Implications for public health and practice

- Strengthen early and continued ANC attendance and use each ANC contact to provide malaria prevention, screening, and health education.
- Improve access to and consistent use of LLINs among pregnant women, with particular attention to rural communities.
- Strengthen IPTp-SP delivery and follow-up through ANC and address service-delivery barriers that may reduce uptake.
- Use community health workers, local-language communication, and other accessible approaches to provide malaria education for women with limited formal education.
- Prioritize malaria prevention and ANC outreach in rural communities and among primigravidae.
- Strengthen routine monitoring of malaria prevalence and prevention coverage at Bor State Hospital and in surrounding communities.

Abbreviations

ITN

insecticide-treated bed nets

LLIN

long-lasting insecticide-impregnated nets

IRS

indoor residual spray

ACT
artemisinin-based combination therapy
IRB
Institutional Review Board
CI
confidence interval
OR
odds ratio
GPS
Global Positioning System, BSH
Bor State Hospital, SSD
South Sudan ANC:antenatal care
AOR
adjusted odds ratio
IPTp
intermittent preventive treatment in pregnancy
IPTp-SP
intermittent preventive treatment in pregnancy with sulfadoxine-pyrimethamine
mRDT
malaria rapid diagnostic test
P. falciparum
Plasmodium falciparum
SPSS
Statistical Package for the Social Sciences.

Declarations

Ethics approval and consent to participate

Written informed consent was obtained from all participants before enrolment in the study and prior to the interviews. Confidentiality and anonymity of participants were maintained throughout the study. Ethical approval was obtained from the Research Ethics Review Board (RERB), Ministry of Health, South Sudan (RERB No. 67/6/6/2026-MOH/RERB/63/2026). The Institutional Review Board and the Medical Director of Bor State Hospital approved the study and granted permission for data collection at Bor State Hospital. All ethical requirements relating to the protection of participants, confidentiality, and anonymity were strictly adhered to throughout the study. All methods were performed in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable. No individual participant-identifying information is reported.

Availability of data and materials

Data for the manuscript is available from the corresponding author.

Competing interest

The authors declare that they have no competing interests. All authors declare that they had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis

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Authors' contributions

Angeth Achiek Kut: conceptualization, study implementation, data collection, data analysis and manuscript preparation. Stephen Chol Jok, participated in data collection, management, and analysis, and drafting and producing the final manuscript.

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