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Factors associated with malaria in pregnancy among antenatal care mothers at Gulu Regional Referral Hospital in northern Uganda

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Abstract

Background All pregnant mothers in Uganda are given sulfadoxine-pyrimethamine (SP, Fansidar[®]) for presumptive treatment of malaria in pregnancy from 14 weeks of gestation, every four weeks, until delivery. However, pre-natal mothers still fall sick of malaria. This study aimed to assess the factors associated with malaria in pregnancy among antenatal care mothers at Gulu Regional Referral Hospital.

Methods This was a cross-sectional study at Gulu Regional Referral Hospital antenatal clinic from July to August 2023. Consecutive sampling was used. An interviewer-administered questionnaire was used to collect sociodemographic characteristics, physical examination findings and blood samples taken for rapid diagnostic test (RDT) for malaria. A positive RDT was taken as the presence of malaria infection in pregnancy. Data was pre-processed in STATA[®] 15, and logistic regression analysis was done in RStudio 4.2.2. Variables with $p < 0.05$ were taken as independently associated with malaria in pregnancy and reported as adjusted risk ratios (aRR).

Results Three hundred fifty (350) pregnant women were recruited; 96% of them slept under mosquito nets daily, while more than half of them (51.7%) had not yet taken SP (IPTp) during their current pregnancy. Prevalence of anaemia (Hb < 11.0 g/dl) was 46.0%. Twenty-four per cent of the mothers were in the first trimester, 56.3% in the second and 19.7% in the third. The prevalence of malaria in pregnancy was 39.7% (95% CI 34.5–45.1%), equally distributed throughout the trimesters. Anaemia (aRR = 4.99, 95% CI 3.10–8.05, $p < 0.001$) and tertiary level of education (aRR = 0.29, 95% CI 0.14–0.62, $p = 0.001$) were significantly associated with malaria in pregnancy. Not sleeping under a mosquito net (aRR = 3.79, 95% CI 0.95–15.16, $p = 0.059$) may be a factor associated with malaria in pregnancy.

Conclusion Four in every ten mothers had malaria infection, with anaemia being a risk factor, while a tertiary level of education was protective against malaria in pregnancy.

Keywords Malaria, Pregnancy, Gulu, Uganda, Africa

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Background

Malaria, a parasitic infection, remains a significant public health concern globally [1]. About 125 million pregnant women live in high-risk areas for malaria infections [2], with the highest rate of morbidity, mortality, and complications in pregnancy being from infections by *Plasmodium falciparum* and *Plasmodium vivax* [3, 4]. Most cases are in sub-Saharan African tropical countries [1]. Uganda accounts for 5% of malaria cases and deaths globally [5]. The Ministry of Health Uganda estimated that malaria accounts for 30–50% of outpatient visits and 15–20% of hospital admissions.

The government of Uganda, under the Ministry of Health, had deployed multiple control measures for malaria in pregnancy, including indoor residual spraying, the use of insecticide-treated bed nets and presumptive treatment with sulfadoxine-pyrimethamine (SP, Fansidar®) [6–9]. Over 95% of mothers attend antenatal care at least once during pregnancy [10] and, therefore, receive the health education and insecticide-treated nets [7, 8]. Despite the recent decline in malaria incidence, it remains a leading cause of morbidity and mortality [11], with prevalence in pregnancy way above 20% [9], and northern Uganda has had many cases of congenital malaria infections at 34.7% [12].

Pregnancy is a state that increases maternal vulnerability to malarial infections [13]. *Plasmodium* parasites prefer placental intervillous spaces, leading to placental infection and inflammation and hindering the exchange of nutrients, waste, and other metabolites between maternal and fetal circulations [14]. This puts the life of a woman and her unborn fetus at risk, which may result in several adverse birth outcomes, including stillbirth, maternal and neonatal mortality, congenital malaria, pre-term birth, maternal anaemia and low birth weight [13]. The World Health Organization (WHO), therefore, recommends intermittent preventive treatment during pregnancy (IPTp) with SP in all areas with high or moderate malaria transmission in Africa, with at least three doses of IPTp-SP during their pregnancy, each dose being given at ≥ 1 month apart, starting as early as possible in the second trimester [14].

Inadequate health education on preventive measures could also be one of the reasons for the increased number of cases of malaria in pregnancy [1]. It has been observed that women who are younger, malnourished, prime gravidae, or living with HIV have reduced immunity and are even at the highest risk of adverse pregnancy outcomes [13]. However, given all the preventive strategies put in place, it is still unknown whether there is a link between malarial infection in pregnancy and any of the above characteristics.

Malaria is the most commonly reported disease in Uganda by public and private health facilities [15]. Social and environmental determinants such as house design can be important determinants of malaria infection [16]. Northwestern Uganda is cooler with more rainfall and has a malaria in pregnancy prevalence of over 20% [9]. It is located in the western Rift Valley, which has hilly and well-drained landscapes with little vegetation cover [9, 17, 18]. On the other hand, the central part of northern Uganda is a flat plateau savannah grassland with dense vegetation and swampy landscapes, ideal for mosquito breeding [17, 18]. No studies have been done to assess the prevalence and the factors associated with malaria in pregnancy in the central part of northern Uganda. Therefore, this study explores the prevalence of malaria in pregnancy among antenatal care mothers at Gulu Regional Referral Hospital, a large referral hospital in the central part of northern Uganda.

Methods

This was a cross-sectional study at Gulu Regional Referral Hospital (GRRH) from July to August 2023, targeting all pregnant women attending the antenatal clinic (ANC), included all pregnant mothers who provided written informed consent and excluded those who were unable to understand and provide responses to questions. Researcher administered pretested questionnaire was given to participants, who also had physical examination and blood samples for a malaria rapid diagnostic test (RDT) taken.

The sample size was determined using Fisher's 2006 formula, i.e. $N = Z^2 PQ / D^2$ where N is the desired sample size, Z is the standard deviation taken as 1.96 at a confidence interval of 95%, P is the prevalence of congenital malaria = 34.7% [12], and D is the Margin of error = 0.05. $Q = (1 - P)$, the population without the desired characteristics. Therefore, $N = (1.96)^2 \times 0.347 (1 - 0.347) / (0.05)^2 = 350$.

The questionnaire was pretested on five midwives to assess the ease of understanding the questions and clarifications/adjustments were made. Numbers were assigned to the first five pregnant mothers who arrived at the health facility each day to select the first participant. Numbers from 1 to 5 were written on a piece of paper, and the paper was folded and placed in the basket (bag) and shaken or shuffled thoroughly. One folded paper was drawn randomly from the basket, and the numbers on it were noted. The participant bearing the number was selected and given the questionnaire to answer. The subsequent participants were selected at intervals of 4 (every fourth pregnant mother was recruited as they came to the facility) until the sample size was obtained.

The data was pre-processed in STATA®15 and analysed in RStudio 4.2.2. The proportions of those who tested positive for *P. falciparum* constituted the prevalence of malaria. Bivariate analysis was done to determine the unadjusted risks of malaria in pregnancy. Any variable with an unadjusted p-value of less or equal to 0.2 was taken to multivariable analysis. A multivariable analysis was done to determine the adjusted factors associated with malaria during pregnancy. A p-value of <0.05 was considered a statistically significant factor associated with malaria in pregnancy.

Results

Three hundred fifty participants were recruited with a mean age of 26.9 years and an interquartile range of 24–30 years. The majority (96.3%) of the mothers sleep under mosquito nets daily, while more than half of them (51.7%) have not yet taken fansidar (IPTp) during the current pregnancy, as shown in Table 1. The prevalence of anaemia was 46.0%, with a haemoglobin level of <11.0 g/dl, as shown in Table 2.

Table 2 Clinical characteristics of pregnant mothers at GRRH

Gestation age at recruitment: < 14 weeks	84	24.0
Gestation age at recruitment: 14–26 weeks	197	56.3
Gestation age at recruitment: > 26 weeks	69	19.7
Haemoglobin level < 11.0 g/dl	161	46.0
Haemoglobin level ≥ 11.0 g/dl	189	54.0
Positive malaria RDT	139	39.7
Negative malaria RDT	211	60.3

Prevalence of malaria in pregnancy

The prevalence of malaria in pregnancy among respondents was 39.7% (95% CI 34.5–45.1%). This was fairly distributed throughout the trimesters, as shown in Table 3.

Factors associated with malaria in pregnancy at Gulu Regional Referral Hospital

Bivariable analysis revealed that unemployment, informal employment or haemoglobin level of the pregnant mother less than 11.0 g/dl were significantly associated

Table 1 Demographic characteristics of pregnant mothers at GRRH

Variable	Frequency	Percentage
Age < 24 years	112	32.0
Age 24–30 years	173	49.4
Age > 30 years	65	18.6
Urban Residence	310	88.6
Rural Residence	40	11.4
Permanent House	177	50.6
Semi-permanent House	64	18.3
Temporary House	109	31.1
Residence near swamp	162	46.3
Residence far from swamp	188	53.7
Attained primary education	84	24.0
Attained Secondary education	192	54.9
Attained Tertiary education	74	21.1
Unemployed (No own income)	22	6.3
Informally employed (no regular salary)	276	78.8
Formally employed (regular salary)	52	14.9
Spouse formally employed	133	38.0
Spouse informally employed	217	62.0
Married	338	96.6
Single	12	3.4
Nulliparous	84	23.4
Para 1–3	236	67.4
Para 4 and above	32	9.1
Sleeps under a mosquito net	337	96.3
Does not sleep under a mosquito net	13	3.7
Had SP (fansidar) for presumptive treatment of malaria	169	48.3
Had not yet taken SP (fansidar) in this pregnancy	181	51.7

Table 3 Prevalence of malaria in pregnancy with gestation age

Gestation age	Population	RDT positive	Prevalence (95% CI)
Less than 14 weeks (First trimester)	84	38	45.2% (34.3–56.5%)
14–26 weeks (Second trimester)	197	73	37.1% (30.3–44.2%)
Over 26 weeks (Third trimester)	69	28	40.6% (28.9–53.1%)
Total study population (Overall)	350	139	39.7% (34.5–45.1%)

Table 4 Unadjusted factors associated with malaria in pregnancy

Variable	Risk ratio (95% CI)	p-value
Age 24–30 years	1.10 (0.80–1.480)	0.582
Age > 30 years	1.22 (0.85–1.76)	0.288
Urban Residence	1.15 (0.74–1.80)	0.532
Semi-permanent House	0.92 (0.0.64–1.33)	0.665
Temporary House	0.83 (0.63–1.11)	0.215
Home near a swamp	0.99 (0.76–1.28)	0.941
Attained Secondary education	1.01 (0.75–1.32)	0.973
Attained Tertiary education	0.52 (0.32–0.84)	0.008
Unemployed (No own income)	2.36 (1.26–4.42)	0.007
Informally employed (no regular salary)	1.81 (1.08–3.03)	0.025
Spouse informally employed	1.46 (1.09–1.97)	0.011
Single	1.05 (0.53–2.08)	0.887
Gestation age at recruitment:14—26 weeks	0.82 (0.61–1.10)	0.189
Gestation age at recruitment: > 26 weeks	0.90 (0.62–1.30)	0.565
Para 1–3	0.99 (0.72–1.35)	0.941
Para 4 and above	1.28 (0.82–1.99)	0.270
Sleeps under a mosquito net	1.75 (0.64–4.76)	0.274
Had SP (fansidar) for presumptive treatment of malaria	0.91 (0.70–1.19)	0.497
Haemoglobin level < 11.0 g/dl	2.53 (1.90–3.39)	< 0.001

Bold values indicate the variable is significantly associated with Malaria in pregnancy

Table 5 Adjusted factors associated with malaria in pregnancy

Variable	Adjusted risk ratio (95% CI)	p-value
Attained Secondary education	0.75 (0.42–1.33)	0.328
Attained Tertiary education	0.29 (0.14–0.62)	0.001
Sleeps under a mosquito net	3.79 (0.95–15.16)	0.059
Haemoglobin level < 11.0 g/dl	4.99 (3.10–8.05)	< 0.001
Intercept	0.12 (0.03–0.49)	0.003

Bold values indicate the variable is significantly associated with Malaria in pregnancy

with malaria in pregnancy. Details are found in Table 4. Multivariable analysis revealed that the predictors of malaria in pregnancy were anaemia, sleeping under a mosquito net and tertiary level of education, as shown in Table 5.

Anaemia was an independent risk factor for malaria in pregnancy, while the tertiary level of education was

protective. Sleeping under a mosquito net was not a statistically significant malaria risk factor in pregnancy in this population.

Discussion

The prevalence of malaria in pregnancy in this study population was 39.7% (95% CI 34.5–45.1%). This is high despite all the preventive measures in place [6–9], although it aligns with previous reports of high malaria incidence in pregnancy in sub-Saharan Africa, supporting the urgency of targeted interventions for this vulnerable group [9, 13]. Another study in northwestern Uganda found 26.1% [9] and another in Tanzania with 8.1% [19] of their pregnant population had malaria. These are lower than what was found in this study.

Additionally, this study found that the majority, 80.9%, had ever suffered from malaria during the current pregnancy, despite 96.6% reported sleeping under treated insecticide mosquito nets and 96.3% reported consistent

use. This could be explained by Schantz-Dunn and Nou [20] stating that pregnant women are more at risk of contracting malaria [20]. Perhaps the few hours before going to bed is all the mosquitoes need to transmit malaria to this vulnerable group.

Health education about different conditions in pregnancy, including malaria prevention and treatment, was given to pregnant mothers every day during the antenatal visits [21–24]. A notable gap in malaria chemoprophylaxis was that 48.3% of women reported to have received SP during the current pregnancy, which indicates that despite efforts of the Ministry of Health to curb the spread of malaria, especially among vulnerable populations [25–27] there were many mothers not receiving the presumptive treatment for malaria. This study also found that up to 72.6% of the mothers had never had any health outreaches organized in their villages. Therefore, incorporating antenatal services in community health outreaches as a means of taking antenatal care services closure to the people would help bridge this gap [28].

The statistically significant factors associated with malaria in pregnancy in this study were anaemia and tertiary level of education. Pregnant women with tertiary education had a reduced risk of malaria, suggesting that educational interventions can positively impact malaria prevention and underscore the need for educational campaigns targeting pregnant women in this region [29]. Anaemia (haemoglobin levels less than 11.0 g/dl) was a risk factor for malaria in pregnancy. However, it is not clear whether malaria in pregnancy is the cause of anaemia or happens to be common among mothers with malaria [14]. The contribution of poor nutrition, owing to the poor socio-economic status of pregnant women and lack of haematinics during pregnancy, cannot be underestimated [30, 31]. Community peer-support groups would go a long way in curbing micronutrient deficiencies like anaemia, including malnutrition [32].

Surprisingly, sleeping under a mosquito net did not demonstrate statistical significance as protective against malaria in pregnancy in our study population. This result is unexpected, as mosquito net usage is a well-established preventive measure for malaria [9]. However, it raises questions about the quality and effectiveness of the nets, compliance with usage, and regional variations that may impact their protective efficacy [33]. It may also raise questions about the proper use of the insecticide-treated nets, considering the fact that the more educated women were less likely to have malaria in pregnancy.

Weaknesses

This study was conducted at a large regional hospital and cross-sectional study, therefore limiting causal inference. It may not fully represent the entire diversity

of the population in northern Uganda. Future research should consider more extensive, diverse samples and employ longitudinal designs to assess causality. Additionally, the use of rapid diagnostic kits solely sensitive to *P. falciparum* leaves a likelihood of missing out on other species of malaria that are possibly in the setting, leading to an underestimation of the prevalence of malaria.

Conclusion

The prevalence of malaria among pregnant women attending antenatal services from Gulu Regional Referral Hospital is high, with almost 4 in 10 pregnant women suffering from malaria. Anaemia and tertiary level of education were significantly associated with malaria in pregnancy.

Recommendations

Increase the coverage of anti-malarial medication, such as sulfadoxine-pyrimethamine (IPTp), for pregnant women to reduce the burden of malaria during pregnancy. This requires the development of streamlined healthcare protocols and comprehensive awareness campaigns to strengthen its administration to all pregnant women.

Implement community-based programs targeting factors associated with malaria in pregnancy. These initiatives should provide education and resources, focusing on peer support networks, to improve malaria prevention and maternal health. Engaging men in antenatal care and malaria prevention can effectively reduce the burden of malaria during pregnancy.

Furthermore, incorporate antenatal services into community health outreaches to enhance accessibility and utilisation of antenatal care. Bringing healthcare services closer to the community will facilitate improved malaria prevention and maternal health strategies.

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Author contributions

S.O., B.S., and L.O. conceptualised the project and collected data; D.O. did data entry and cleaning; J. A. and R.O. drafted and reviewed the manuscript; J.O., B.A., F.P.P., V.A., and Sande_O. guided in data collection and proofreading the manuscript; Ben_A did data analysis; and S.A. guided the students through the conceptualisation, data collection, analysis, manuscript drafting, and proofreading of the manuscript.

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Availability of data and materials

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The research was approved by the Department of Public Health at Gulu University and the Gulu University Research and Ethical Committee (Ref: GUREC-2023-551). Administrative clearance was obtained from Gulu Regional Referral Hospital, and written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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