

Original Article

Prevalence of and factors associated with placental malaria in the White Nile State: a cross-sectional studyAbdelmageed Elmugabil¹, Itedal Ahmed^{2,3}, Lobna E Ali⁴, Mohammed Alorini⁵, Ahmed A Mohammed⁶, Ishag Adam⁷¹ El Imam El Mahdi University, Kosti, Sudan² Department of Anatomy, Najran University, Saudi Arabia³ Faculty of Medicine, Gezira University, Sudan⁴ Department of Histopathology and Cytology, Ahlia College of Medical Laboratory Sciences, Port Sudan, Sudan⁵ Department of Pathology, College of Medicine, Qassim University, Unaizah, Saudi Arabia⁶ Faculty of Medicine, Ribat University, Khartoum, Sudan⁷ Department of Obstetrics and Gynecology, College of Medicine, Qassim University, Buraydah, Saudi Arabia**Abstract**

Introduction: Malaria during pregnancy can lead to maternal and perinatal adverse effects. Despite the preventive measures, recent research has shown that malaria during pregnancy is still a threatening health problem, especially in Sub-Saharan African countries. The current study was conducted to determine the prevalence of and factors associated with placental malaria in Rabak Hospital in central Sudan.

Methodology: A cross-sectional study was conducted from September to October 2021. Pregnant women who delivered at the Rabak Maternity Hospital in Central Sudan were included. A questionnaire was used to gather both obstetric and socio-demographic information. Blood films for malaria were prepared using the maternal, placental, and cord blood, and a placental histology was performed. A logistic regression analysis was performed.

Results: For the 208 women, the medians (interquartile range) of their age and parity were 25 (21.0–30.0) years and 2 (1–4), respectively. Twenty-five (12.0%) of the women had used insecticide-treated nets. Active infection, active-chronic infection, and past-chronic infection were detected in four (1.9%), five (2.4%), and 35 (16.8%) placentas, respectively. One hundred and sixty-four (78.8%) placentas showed no signs of infection. Logistic regression analysis showed that none of the examined factors (age, parity, education, antenatal care level, use of insecticide-treated nets, and blood group) was associated with placental malaria.

Conclusions: Malaria affects 20% of pregnant women, regardless of their age and parity. Preventative measures should therefore be encouraged in this area.

Key words: Malaria; pregnancy; prevalence; risk factors; ITN.

J Infect Dev Ctries 2024; 18(5):817-821. doi:10.3855/jidc.18466

(Received 05 May 2023 – Accepted 08 October 2023)

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Introduction

Due to various immunological factors, pregnant women are more susceptible to malaria infections as compared to their non-pregnant counterparts [1]. Despite preventative measures, malaria remains a public health issue among pregnant women in endemic areas, and it can lead to several adverse effects on both the mother and her fetus [2]. It has been estimated that in 2020, globally there were 120.4 million pregnant women at risk of *Plasmodium falciparum* malaria [3]. Several recent studies have shown a high burden of malaria infection among pregnant women in sub-Saharan African countries [4–9], including Sudan [1,10]. Recently, Mangusho *et al.* have shown that 26.1% of pregnant women in Uganda had *P. falciparum*

malaria [11]. Moreover, recent reports in sub-Saharan Africa have shown that malaria infection during pregnancy is associated with poor maternal and perinatal effects including maternal anemia and low birth weight [2]. Malaria infection during pregnancy has also been associated with primiparity and younger age in several locations in sub-Saharan Africa [4–9].

Malaria during pregnancy could hinder the achievement of the Sustainable Development Goals of reducing maternal mortality in endemic countries [12]. Thus, it is essential to assess the prevalence of and factors associated with malaria during pregnancy in each setting in order to create a set of evidence-based potential interventions. Therefore, a study to assess the prevalence of malaria during pregnancy and its

associated factors is necessary for researchers, physicians, and health planners; it also provides information for the entire health. Sudan is the second largest country in Africa, and malaria is a significant health problem there. Most, if not all, of the previous reports on malaria during pregnancy were conducted in Central and Eastern Sudan [4,13,14]. It seems, however, that there is no published data on malaria during pregnancy in Sudan's White Nile state. Thus, this study investigated the prevalence of and factors associated with placental malaria in Rabak Hospital in Central Sudan.

Methodology

Study area

A cross-sectional study was conducted at the Rabak Maternity Hospital in Rabak, the capital of the White Nile state of Sudan, from September to October 2021. It is one of the major cities of Sudan. Rabak lies some 362 meters above sea level and its geographical coordinates are 13°9'0" North, 32°44'0" East [15]. The area is characterized by unstable malaria transmission, mainly during the rainy and post-rainy seasons of June through November; *Plasmodium falciparum* is the sole species in the area [16].

Study design and data collection

Consecutive pregnant women who delivered at Rabak Maternity Hospital and signed an informed consent form were included. Exclusion criteria were: women who were less than 28 weeks pregnant at the time of delivery or had a multiple pregnancy, hemorrhage, or systemic diseases such as diabetes, thyroid disease, hypertension, and intrauterine fetal death.

A questionnaire was used to gather obstetric, clinical, and sociodemographic data (age, parity, education level, antenatal care level, use of insecticide-treated nets (ITN), and blood group).

Blood films for malaria were prepared from the peripheral (maternal), placental, and cord blood; the slides were Giemsa-stained and double-checked blindly by an expert microscopist. The placental histology was performed as previously described [13,14]. In summary, four cm³ full-thickness placental blocks were taken and kept in neutral buffered formalin for histopathological examinations. Following the embedding of the biopsies in paraffin wax, the thick paraffin sections were stained with hematoxylin-eosin and Giemsa stains. As described previously [17], placentas were classified as uninfected, actively infected, actively chronically infected and past-

chronically infected depending on the presence/absence and localization of parasites in maternal erythrocytes in the intervillous space, pigment in erythrocytes and circulating monocytes within the intervillous space and pigment in fibrin or cells within fibrin.

The sample size of 208 women was estimated (n) with an assumed level of prevalence of placental malaria of 20%. This percentage was previously reported in Eastern Sudan [13,14] using a single proportional formula $n = Z^2 pq/d^2$, where n is the desired sample size, p is the proportion (prevalence) of the disease in the target population under the study, q = (1-p), Z is the standard normal deviate (1.96), corresponding to a 95% confidence level, and d is the margin of error of 5% = 0.05.

Data analysis

The data was analyzed using SPSS for Windows version 22 (IBM, Armonk, NY, USA). The data was checked for normality using a Shapiro-Wilk test; data was not normally distributed. The median (interquartile range [IQR]), frequency, and percentage were used to define the participants' characteristics (age, parity, education, antenatal care level, using ITN, and blood group). Univariate analyses were performed with placental malaria as the dependent variable and various sociodemographic and obstetric factors (age, parity, education, antenatal care level, using ITN, and blood group) as the independent variables. Multicollinearity was evaluated (if a variance inflation factor > 4). Variables with a $p < 0.200$ were shifted to build a multivariable analysis; additionally, a backward likelihood ratio (LR) was used to evaluate the independent effects of each covariate by controlling the effects of other variables. The adjusted odds ratios (AOR) and 95% confidence intervals (CI) were also computed; a p value of less than 0.05 was considered statistically significant.

Ethics approval

This study received ethical clearance from the ethical committee of the Faculty of Medicine at El Imam El Mahdi University, Kosti, Sudan (#2021, 08). Women signed an informed consent.

Results

Two hundred and twenty-four women were initially screened for the study; sixteen met the exclusion criteria and were removed. Among the 208 women selected, the median (IQR) of their ages and parities was 25 (21.0 – 30.0) years and 2 (1–4), respectively. One hundred and twenty-eight women (61.5%) had achieved less than

secondary education and 35 (16.8%) had received two or fewer antenatal visits. Twenty-five (12.0%) women indicated a history of using ITN. One hundred and nineteen (57.2%) women were blood type O. All of the peripheral and cord blood films were negative for malaria; four placentas were positive for *P. falciparum*. Active infection, active-chronic infection, and past-chronic infection were detected in four (1.9%), five (2.4%), and 35 (16.8%) placentas, respectively. One hundred and sixty-four (78.8%) of placentas had no evidence of infection. In total, 44 (21.2%) placentas showed evidence of malaria infection, whether active, active-chronic, or past-chronic). The four placentas that were blood-film positive had active infections. There were no significant differences in age, parity (or number of primiparous), level of antenatal care level, level of ITN use, or blood type between the women with placental malaria and women without placental malaria. As compared to the women who tested negative for placental malaria, the women who tested positive had lower levels of education (Table 1). Finally, logistic regression analysis showed that none of the factors studied were associated with placental malaria (Table 2).

Discussion

This study indicated that 21.2% of the participants had suffered from a placental malaria infection; most were past-chronic. A similar prevalence (19.5%) of placental malaria infections was previously reported in Eastern Sudan using the same method (placental histology) [13]. The prevalence of placental malaria infection (21.2%) in this study was higher than the prevalence (17.0%) of placental malaria in Central Sudan [14]. However, the prevalence of placental

Table 2. Adjusted logistic regression for factors associated with placental malaria in Rabak Hospital, Sudan, 2021.

Variables	Odds ratio (95.0% confidence interval)	<i>p</i>
Parity	1.09 (0.94–1.28)	0.235
Education level		
≥ secondary	Reference	
< secondary	1.97 (0.90–4.28)	0.086
Blood group		
O	1.52 (0.75–3.10)	0.243
Other than O	Reference	

malaria infection found in this study (21.2%) was lower than the reported levels of placental malaria (1.5%, 2.7%, and 30.4% of the 339 placentas had active, active-chronic, and past-chronic malaria infection, respectively) in Eastern Sudan [10]. It has been shown that 59.3% of the placental films had *P. falciparum* infections in Sudan’s Blue Nile state [4]. The prevalence of placental malaria in our study was comparable to that (18.0%) recently reported in Kenya [7]. In Ghana, one out of every five pregnant women in the antenatal care clinic had a *P. falciparum* infection [18]. Mangusho *et al.* have shown that 26.1% of pregnant women in Uganda had *P. falciparum* malaria [11]. Recently, in their meta-analysis of 24 studies (n = 14,087 pregnant women), Boltena *et al.* [19] indicated that the pooled prevalence of malaria in sub-Saharan Africa was 33.0%. Moreover, a previous meta-analysis of 35 studies indicated that the overall prevalence of asymptomatic *P. falciparum* infection was 26.1% in pregnant women in sub-Saharan Africa [9]. The difference in the prevalence of malaria during pregnancy could be explained by the different intensity malaria intensity in different areas, by socio-economic differences and by the different methods used to diagnose malaria itself, e.g., in some of these studies a

Table 1. Comparing variables between women with placental malaria positive and placental malaria negative in Rabak Hospital, Sudan, 2021.

Variables	Placental malaria positive (n = 44)	Placental malaria negative (n = 164)	OR (95% CI)	<i>p</i>
Median (interquartile range)				
Age	25 (21.0–30.1)	25 (21.0–30.)	1.02 (0.97–1.08)	0.349
Parity	3 (1–6)	2 (1–4)	1.14 (0.99–1.33)	0.067
Frequency (proportion)				
Parity				
Primipara	10 (22.7)	50 (30.5)	0.67 (0.30–1.36)	0.315
Parous	34 (77.3)	114 (69.5)	Reference	
Education level				
≥ secondary	11 (25.0)	69 (42.1)	Reference	0.042
< secondary	33 (75.0)	95 (57.1)	2.17 (1.03–4.61)	
Antenatal care				
> two visits	38 (86.4)	135 (82.3)	Reference	0.525
≤ two visits	6 (13.6)	29 (17.7)	0.73 (0.28–1.90)	
Using insecticide treated nets				
Yes	3 (6.8)	22 (13.4)	Reference	0.241
No	41 (93.2)	142 (86.6)	2.11 (0.60–7.43)	
Blood group				
O	29 (65.9)	90 (54.9)	1.59 (0.79–3.18)	0.191
Other than O	15 (34.1)	74 (45.1)	Reference	

blood film was used while in others a rapid test was used.

This study found no association between placental malaria infection and either age or parity. This is in line with our previous findings in both Eastern [10,13] and Central Sudan [14]; neither study showed any association between either age or parity and placental malaria infections. However, primiparas were reported to be associated with placental malaria in the Blue Nile state in Sudan [4]. In Uganda, a recent study reported no association between age and malaria during pregnancy [11]. In Nigeria [5] and in West Ethiopia [6] malaria during pregnancy was associated with age and parity. Moreover, in Kenya, asymptomatic placental malaria infection was associated with younger mothers [7]. In Ghana, it has been shown that primigravidas are more than three times as likely to contract placental malaria as multigravidas [8]. A recent meta-analysis of 35 studies showed that primigravidas have a 1.54 times higher risk of asymptomatic malaria infection than multigravidas in sub-Saharan Africa [9]. The differences between the results of the current study and other similar studies in terms of prevalence and association between malaria infections, age, and parity could be due to differences in the level of malaria endemicity in the different countries, which would lead to differences in immunity [1].

The results indicated that only 12.0% of the participants had used ITN; as such, the use of ITN was not associated with placental malaria. This is in line with previous findings in Eastern Sudan, which also showed that the use of ITN was not associated with placental malaria infection [10]. Moreover, Mwin *et al.* and Rouamba reported no associations between ITN and malaria infection during pregnancy either in Ghana or in Burkina Faso, respectively [20,21]. Several additional studies have reported on this lack of relationship between malaria infection during pregnancy and using ITN as well [5,6,22]. The lack of association between using bed nets and placental malaria could be explained by the low rate (12.0%) of bed net use in this setting. A recent analysis of the demographic and health survey data of 21 sub-Saharan African countries, which included 17,731 pregnant women, has shown that three-quarters (74.2%) of pregnant women used ITNs [23]. It is worth mentioning that the efficiency of ITN in preventing malaria during pregnancy might not be optimal in areas characterized by unstable malaria transmission; this would include Sudan [22,24,25]. A recent study showed that pregnant women in Uganda who did not use ITN were at higher risk of having malaria infection [11].

Conclusions

As 20% of pregnant women are affected by malaria, regardless of their age and parity, prevention measures should be promoted in the region.

Authors' contribution

AE, DAR, and IA designed the study. AE, IA, and MA collected the data. LEA, MA, and AAM conducted the laboratory work. AE and IA conducted the statistical analysis. All authors contributed to the writing of the manuscript and approved the final version for publication.

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Conflict of interests: No conflict of interests is declared.