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*Plasmodium vivax* malaria among pregnant women in Eastern SudanDuria Abdulwhab Rayis<sup>1</sup>, Mohamed Awad Ahmed<sup>2</sup>, Elsir Mirghani Omer<sup>2</sup>, Ishag Adam<sup>1\*</sup><sup>1</sup>Faculty of Medicine, University of Khartoum, P. O. Box 102, Khartoum, Sudan<sup>2</sup>Department of Obstetrics and Gynecology, New Halfa Hospital, New Halfa, Sudan

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## ABSTRACT

**Objective:** To determine the epidemiology of malaria [especially *Plasmodium vivax* (*P. vivax*)] among pregnant women in Eastern Sudan.**Methods:** A cross sectional study was conducted in the antenatal care of New Halfa hospital, Eastern Sudan to investigate the prevalence, manifestations and determinants of malaria (especially *P. vivax*) among pregnant women.**Results:** Out of 2378 pregnant women, there were 48 (2.0%) and 36 (1.5%) *Plasmodium falciparum* (*P. falciparum*) and *P. vivax* infection, respectively. There was no significant difference in the age, parity, gestational age between women with malaria and healthy controls. The mean  $\pm$  SD of the temperature was significantly higher in patients with *P. vivax* than in patient with *P. falciparum* malaria [(38.6  $\pm$  0.7) °C vs. (38.1  $\pm$  0.6) °C,  $P = 0.001$ ]. Patients with *P. vivax* malaria had slightly (not reach statistical significance) lower hemoglobin level compared with *P. falciparum* malaria and healthy controls. The geometric parasite count showed no significant difference between patients with *P. vivax* and *P. falciparum* malaria infections (12 189.9 vs. 9755.1 trophozoite/ $\mu$ L,  $P = 0.356$ ).**Conclusions:** *P. vivax* malaria is an existing health problem in Eastern Sudan. Further research is also needed.

## 1. Introduction

There are over 125 million pregnant women at risk of malaria. The majority (40 million) of these are at risk of *Plasmodium vivax* (*P. vivax*) and 32 million are at risk of *Plasmodium falciparum* (*P. falciparum*), and 53 million are at risk of co-infection of both *P. vivax* and *P. falciparum*[1]. Pregnant women are at increased risk, density and multiplicity of *P. vivax* infections than the non-pregnant ones[2-6].

In malaria endemic areas (especially areas of low malaria transmission), both *P. falciparum* and *P. vivax* infections have adverse effects on placental development and fetal outcomes[7-9]. It has been reported that compared to non-infected pregnant women,

*P. vivax*-infected pregnant women were at higher risk of anemia and have lower birth weights in babies[2,10,11].

In sub-Saharan Africa (including Sudan), where the vast majority of malaria infections are due to *P. falciparum*, the placental infections and the adverse pregnancy outcomes have been extensively studied including epidemiology, anemia and low birth weight[12-15].

In sub-Saharan Africa, the paradigm of the Duffy antigen dependence for *P. vivax* and the benign character formerly attributed to *P. vivax* infection were challenged by the increasing number of reports of *P. vivax* in the blood of Duffy-negative individuals and severe disease associated with *P. vivax* infection[16-19]. There are few published data (especially in Africa) on *P. vivax* infection during pregnancy and no published data on *P. vivax* infection during pregnancy in Sudan[20,21]. This study was conducted to determine the epidemiology of malaria (especially *P. vivax*) among pregnant women in Eastern Sudan.

## 2. Materials and methods

A cross sectional study was conducted in the antenatal care of New Halfa hospital in the Eastern Sudan during the post-rainy season (August-December 2014). The area of the study is

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The study protocol was performed according to the Helsinki declaration and approved by Research Board at the Department of Obstetrics and Gynecology, Faculty of Medicine, University of Khartoum, Sudan. Informed written consent was obtained from Ministry of Health, Kassala, Sudan.

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characterized by unstable malaria transmission. *P. falciparum* was the main species encountered in the area[22]. However, in the last few years, *P. vivax* infections were reported and even severe cases of *P. vivax* were observed[19]. After signing an informed consent from both the cases of malaria and healthy controls, obstetrics and medical (age, parity, gestational age) history were gathered using questionnaire. The women's weight and axillary temperature were recorded. The data of pregnant women who had malaria infection (*P. vivax/P. falciparum*) and healthy controls women were recorded.

The hemoglobin was measured. Women with malaria were treated with artesunate sulfadoxine-pyrimethamine which is the first line treatment for malaria in Sudan[23].

### 2.1. Blood smears for malaria and light microscopy

The blood smears were prepared as described in the previous work[13]. In summary, thick and thin blood films were prepared and stained with 10% Giemsa and examined under the 100 oil-immersion objective lens of a light microscope. The asexual parasites density was counted per 200 leukocytes assuming a leukocyte count of 8000 leukocytes/ $\mu$ L (for thick films) or per 1000 red blood cells (for thin films). Blood films were considered negative if no parasites were detected in 100 oil-immersion fields of a thick blood film.

### 2.2. Statistics

The data were entered into computer using SPSS for Windows. The mean  $\pm$  SD of the medical and obstetrical variables (age, parity, gestational age, weight, hemoglobin) was compared between the women in the three groups (*P. vivax*, *P. falciparum* and healthy controls) using One-way ANOVA with *Post-hoc* Bonferroni analyses. The parasite count was compared between women with *P. vivax* and *P. falciparum* malaria by non-parametric test.

### 2.3. Ethics

The study protocol was performed according to the Helsinki declaration and approved by Research Board at the Department of Obstetrics and Gynecology, Faculty of Medicine, University of Khartoum, Sudan. Informed written consent was obtained from Ministry of Health, Kassala, Sudan.

## 3. Results

A total of 2378 women attended the antenatal clinic during the study period. Out of these, there were 48 (2.0%) and 36 (1.5%) *P. falciparum* and *P. vivax* infection, respectively (ratio = 1.3:1.0). There was no *P. falciparum* and *P. vivax* co-infection. There was no significant difference in the age, parity, gestational age between women with malaria and healthy controls (Table 1).

**Table 1**

The pregnant women with *P. vivax* and *P. falciparum*, and healthy controls at Eastern Sudan.

Variables	<i>P. vivax</i> (n = 36)	<i>P. falciparum</i> (n = 48)	Healthy controls (n = 36)	P
Age (years)	29.4 $\pm$ 6.0	27.2 $\pm$ 6.3	29.2 $\pm$ 5.1	0.161
Parity	2.8 $\pm$ 2.2	2.3 $\pm$ 2.7	2.2 $\pm$ 2.2	0.570
Gestational age (weeks)	24.7 $\pm$ 5.7	23.2 $\pm$ 5.6	24.1 $\pm$ 5.2	0.532
Weight (kg)	59.1 $\pm$ 6.4	61.6 $\pm$ 6.5	60.1 $\pm$ 5.3	0.001
Temperature ( $^{\circ}$ C)	38.6 $\pm$ 0.7	38.1 $\pm$ 0.6	37.2 $\pm$ 0.3	< 0.001
Hemoglobin	9.4 $\pm$ 1.1	9.9 $\pm$ 1.2	10.0 $\pm$ 1.1	0.084

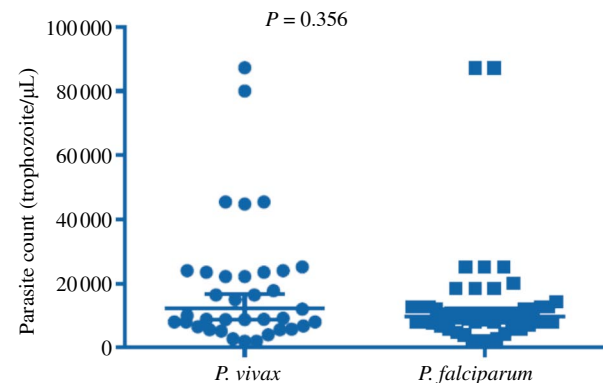
All values were expressed as mean  $\pm$  SD. -: Absent.

The mean  $\pm$  SD of the temperature was significantly higher in

patients with *P. vivax* compared with patients with *P. falciparum* malaria [(38.6  $\pm$  0.7)  $^{\circ}$ C vs. (38.1  $\pm$  0.6)  $^{\circ}$ C, *P* = 0.001].

Patients with *P. vivax* malaria had slightly (not reach statistical significance) lower hemoglobin level compared with *P. falciparum* malaria and healthy controls (Table 1).

There was no significant difference in the geometric parasite count between patients with *P. vivax* and *P. falciparum* malaria infections (12 189.9 vs. 9 755.1 trophozoite/ $\mu$ L, *P* = 0.356) (Figure 1).



**Figure 1.** The geometric mean of the parasite count in *P. vivax* and *P. falciparum* malaria among pregnant women in Eastern Sudan.

## 4. Discussion

This is the first report of *P. vivax* malaria infections among pregnant women in Sudan. The previous reports have shown that *P. falciparum* was the sole species among pregnant women in the Eastern and Central Sudan[13,15,24]. It has recently been shown that *P. vivax* malaria is an existing health problem and even severe cases of *P. vivax* were observed among both children and adults in Eastern Sudan[18,19]. The influx of the Ethiopians through the border after signing the peace agreement was the explanation mentioned by some researchers[18]. There are generally few reports of *P. vivax* infections among pregnant women in Africa and *P. vivax* was considered rare before[20,21].

In the current study, there was no significant difference in the mean age and parity between pregnant women with *P. falciparum* and *P. vivax* infections, and healthy controls women. This goes with the previous reports where it has been shown that pregnant women in Eastern and Central Sudan were susceptible to *P. falciparum* infections regardless to their age and parity, and the low transmission of the malaria infections in the area was the main explanation. On the other hand, primigravidae were observed to have an increased risk of *P. falciparum* and *P. vivax* compared to multigravidae[25].

Interestingly, in this study, women with *P. vivax* malaria had significantly higher temperature than women with *P. falciparum* malaria. This goes with previous studies that showed that *P. vivax* had a lower pyrogenic threshold and cytokines released compared to *P. falciparum*[26-28]. Fever as well as the other clinical consequences of *Plasmodium* infection are manifest during the blood-stage of infection and are worsened by high densities of the parasitemia. The lower pyrogenic threshold and densities of the parasitemia could be explained by the ability of *P. falciparum* to invade all erythrocytes, whereas *P. vivax* selectively infests young erythrocytes (reticulocytes), and thus *P. vivax* could have a lower parasitemia than *P. falciparum*[29,30].

### 4.1. Limitations of the present study

The study was small size and might lack the power to estimate the difference between the *P. vivax* and *P. falciparum* malaria. Only

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