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## Original article

### Prevalence of *Plasmodium* species in patients attending in Ed-Babiker Health Center in Khartoum State, Sudan

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##### Abbreviations:

**BF:** Blood film

**EDTA:** Ethylenediaminetetraacetic acid

**PCR:** Polymerase chain reaction

**SPSS:** Scientific Package for Social

Sciences

**WHO:** World Health Organization

#### ABSTRACT

**Background:** Malaria is a serious vector-borne tropical disease that remains one of the primary reasons for death in several developing countries. In Sudan, almost 75% of the population is at risk of developing malaria. **Objective:** To study the prevalence and diversity of *Plasmodium* species based on the data collected in a health center-based survey in Ed-Babiker Health Center-Sudan. **Methods:** This was cross-sectional malaria survey carried out in Ed-Babiker Health Center during the colder season from December 2020 to March 2021. The survey was categorized according to gender and age groups. **Results:** The overall prevalence of *Plasmodium* species among malaria suspected cases was 33%. *Plasmodium falciparum* (*P. falciparum*) was the main infecting malaria species in Ed-Babiker Health Center as we found that about (24%) of cases were infected with that species. The prevalence showed significant variations between the localities ( $p$  value  $<0.001$ ), which could be explained by differences in population movement, refugees' presence of and proximity to endemic neighboring states. **Conclusion:** Even though malaria in Ed-Babiker Health Center is still largely recognized to *P. falciparum*, *P. vivax* has been growing with worrying proportions and spreading to new areas. The emergence and marked increase of *P. vivax* poses new challenges to malaria treatment and control in Ed-Babiker Health Center.

#### Introduction

In spite of the remarkable progress that has been made in the fight against malaria, it remains an important public health problem in Sudan [1]. Almost; 75% of the Sudanese population is at risk of developing malaria. Malaria transmission is unstable putting the whole country at risk of a malaria epidemic. The possibility of epidemic increased with

heavy rains, floods, and in case of the interval of control goings-on [2].

Malaria transmission in Sudan is extremely related to climatic situations. There are two peaks of transmissions; one during the rainy season and other during the winter season. Malaria during the rainy season includes most of the areas in Sudan. In urban areas and during the rainy season involves most of the

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areas in Sudan. In urban areas and in irrigated schemes the transmission is throughout the year with an obvious peak during winter. Six epidemiological malaria levels could be identified: irrigated schemes, seasonal man-made urban, desert-fringe, riverine and emergency and complex situation malaria [2]. Efforts to prevent and control malaria contribute to and benefit from sustainable development. The objectives of reducing the disease burden and eliminating malaria are closely linked to several sustainable development goals being considered for the post-2015 period [3].

According to the World Health Organization (WHO), five *Plasmodium* species have been recognized as the causative agents of malaria that can infect humans: *Plasmodium falciparum* (*P. falciparum*), *Plasmodium vivax* (*P. vivax*), *Plasmodium ovale* (*P. ovale*), *Plasmodium malariae* (*P. malariae*) and *Plasmodium knowlesi* (*P. knowlesi*). Of these five species *P. falciparum* and *P. vivax* are the most common in Sudan.

Microscopical examination of blood films is the mainstay of malaria diagnosis that can adequately detect *Plasmodium* infections in patients with high levels of parasitaemia [4]. This study was proposed to improve the basic epidemiological description of malaria risk within the metropolis limits of Khartoum leading to a more informed basis for future efforts to eliminate malaria from this area of Sudan.

The objective of this study is to study the prevalence and diversity of *Plasmodium* species based on the data collected in a health center-based survey in Ed-Babiker Health Center.

## Materials and Methods

### Study setting

This study was carried out in Ed-Babiker Health Center which is located in Shergalnile locality located in Khartoum State and consists of the city of Bahri, the northern country side, the eastern country side and the southern country side. These were from the basis of a prospective, enhanced facility-based surveillance of fever cases (defined as a history of fever during current illness history and/or an axillary temperature  $\geq 37.5^{\circ}\text{C}$ ).

### Study design and population

This was a descriptive cross-sectional, quantitative study. The surveys were carried out in colder season December 2020, to March 2021. The center was surveyed as basis of a prospective, enhanced facility-based surveillance of fever cases (defined as a history of fever during current illness history and/or an axillary temperature  $\geq 37.5^{\circ}\text{C}$ ).

Data and blood samples were collected from hundred patients suspected of having malaria attending the target hospital and primary health centers; they were categorized according to gender and age groups.

### Data collection

The medical doctor filled in a clinical form to collect demographic data (age and gender) and signs and symptoms of malaria (fever, chills, sweating, headache, myalgia, arthralgia, abdominal pain, nausea, vomiting, dizziness, cough, dyspnea and diarrhea).

All the recruited patients then filled in a questionnaire to collect data about their residence status

### Collection of blood samples

A venous Ethylenediaminetetraacetic acid (EDTA) blood sample was collected by venipuncture from each individual. After that thin and thick blood smears were prepared.

### Blood films microscopy

The blood films were stained by freshly prepared 10% Giemsa stain for 10 min and carefully rinsed with buffered water then dried. The thick part of the blood film was examined using 100 x magnifications, and up to 100 fields were checked before considering the slide as negative. The thin film was examined for *Plasmodium* species identification.

Two experienced parasitologists examined the slides at the field site and then rechecked by a more experienced laboratory technician at the Parasitology Department- Administration Lab-Khartoum state, following WHO criteria for malaria diagnosis [3].

### Data analysis

Relevant data were analyzed statistically using the computer program, Statistical package for social sciences (SPSS), version 21 (SPSS Inc., Chicago, IL).

## Results

### Demographic data

The study included 100 blood film samples collected from patients admitted to Ed-Babiker Healthy Center to estimate the prevalence of *plasmodium* species.

All patients were clinically diagnosed with malaria before being confirmed microscopically for malaria parasite presence. Both genders were included, with males representing 58 (58%) and females 42(42%), (Table 1). Patients were categorized into many age groups according to WHO age criteria. Most participants have age ranges from 6 to 15-year old (Figure 1).

### Microscopic examination

All samples were examined microscopically for malaria parasites to the species level using thin and thick blood film.

Out of 100 suspected participants 33(33%) were confirmed positive, the remaining 67(67%) were

routed out as non-diseased participants, (Figure 2). The positive samples were further examined to reveal the causative *plasmodium* species, 24 (72.7%) were found positive for *P. falciparum* while 9 (27.3%) were positive for *P. vivax* (Table 2).

Out of the positively confirmed samples, 18 samples belonged to male participants and 15 samples for female participants. In reverse, the total number of

negative samples according to females and male genders was 43 (43%) and 24 (24%) respectively (Table 3).

The study included different age groups with the age group 6-15 holding the highest prevalence rate and the species *P. falciparum* presenting the major causing species (Table 4).

**Table 1.** The distribution of the participants according to gender.

Gender	Percentage
Male	58%
Female	42%

**Table 2.** The prevalence of malaria among patients attending the Ed-Babiker Health Center.

		Number
Positive	<i>P. falciparum</i>	24
	<i>P. vivax</i>	9
Total		33
Negative		67

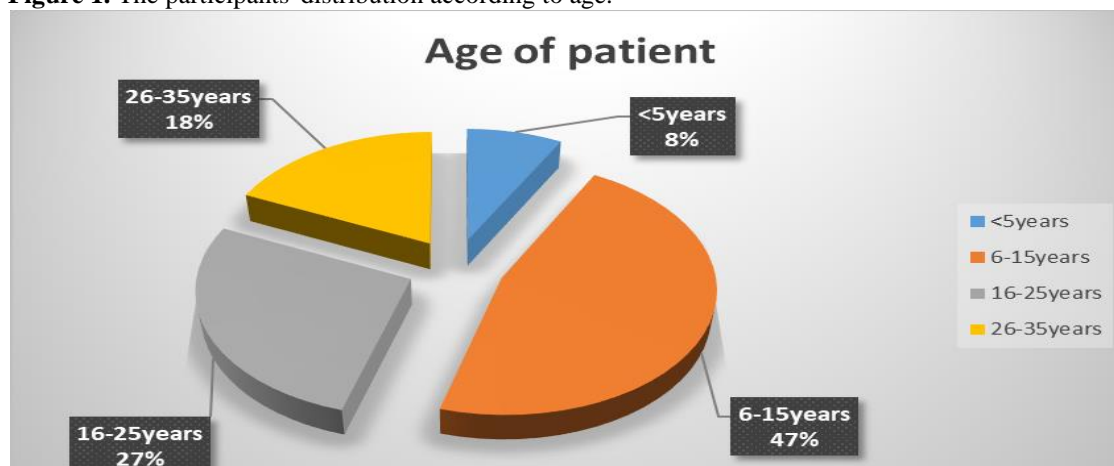
**Table 3.** Prevalence rate of malaria species infection among patients attending Ed-Babiker Health Center according to gender.

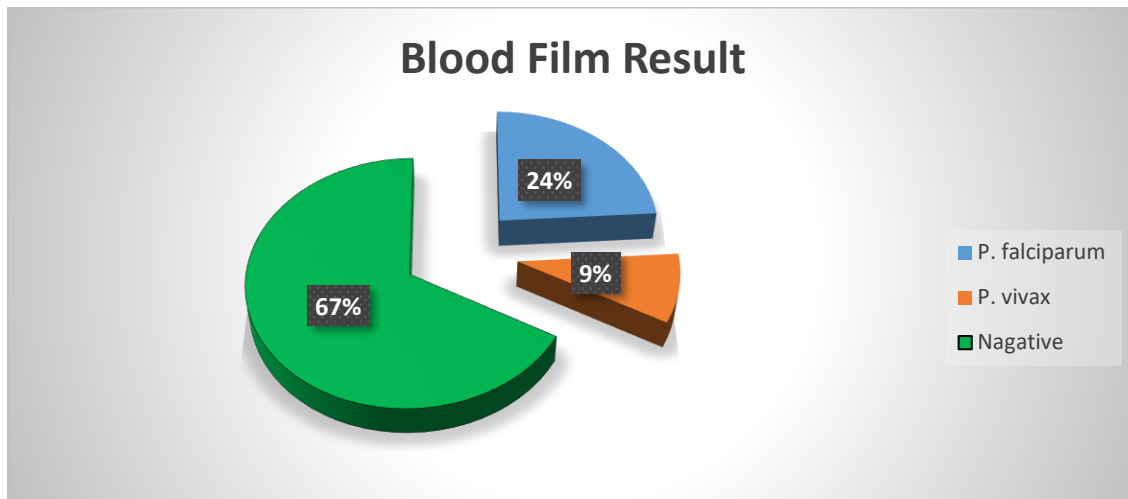
	Males	Females	Total
<i>P. falciparum</i>	13	11	24
<i>P. vivax</i>	5	4	9
Total	18	15	33

**Table 4.** Prevalence rate of malaria species infection among patients attending Ed-Babiker Health Center according to age categories.

	<i>P. falciparum</i>	<i>P. vivax</i>	Negative	Total
<5years	0	2	5	7
6-15years	12	4	25	41
16-25years	6	1	17	24
26-35years	3	1	12	16
>35years	3	1	8	12
Total	24	9	67	100

**Figure 1.** The participants' distribution according to age.



**Figure 2.** The result of blood films of malaria among patients attending in Ed-Babiker Health Center.

### Discussion

*Plasmodium* species have a wide geographic distribution in Africa. *P.falciparum* has dominant distribution in Sudan especially in Khartoum state. Recently *P. vivax* has shown an increased clinical burden in an unexpected manner that needs to be taken care of by health authorities [5].

We need to investigate how this clinical burden is effectively managed within the public health sector and how more detailed case data might be used to target focal control. For areas aiming for elimination there is an increasing need to enhance clinical surveillance with increasing sensitivity of parasite detection not always afforded by routine microscopy [6]. This study found that the prevalence of *plasmodium* species in Ed-Babiker Health Center was 33%. This rate is far from the previous rate found in a study conducted by **Bruce et al.**, and it was (24.5%) [7].

Obviously, the main infecting malaria species in Ed-Babiker Center was *P. falciparum* constituted (72.7%) of total positive cases were infected with that species. This agrees with a previous study conducted by **Bruce et al.** [7]. On the other hand, the *P.vivax* prevalence rate reached 9 % of cases, the same results presented by the Sudan federal ministry of health [8].

Results revealed that the most affected age group falls between 6 and 15-years old. The most likely explanation is that this age group is the most exposed to the mosquitoes biting as they are highly active, mobile, and care nothing about their health.

Microscopic results were initially considered as the reference standards for true positive and true negative results. Many studies have demonstrated the greater sensitivity and specificity of PCR compared to thick blood films [9].

### Conclusion

*Plasmodium falciparum* remains the most common infecting malaria species in Sudan; however there is a considerable elevation of *P.vivax* infectivity rate in Sudan especially in Ed-Babiker area. This represents an alarm for the health authority to interfere with putting an end to this growing problem.

Although there is a good diagnosing capacity for malaria, there is a growing demand for continuous training for laboratory technicians to enhance diagnostic reliability.

### Acknowledgements

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### Authors' contributions

SHO and SSA conceived the design and carried out the experiments. AAI and RMA and AMA and EKA obtained, analyzed and interpreted the data. MMA and HAH and RAE wrote and revised the manuscript. MAH provides financial support for all experiments. All authors read and approved the final manuscript.

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### Availability of data and materials

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

**Ethics approval and consent to participate**

Each participant was asked to sign a written ethical consent form during the interview, before the specimen was taken. The informed ethical consent form was designed and approved by the ethical committee of the Faculty of Medical Laboratory Research Board, National University-Sudan.

**Consent for publication:** Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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