A comparative study of Prevalence, Manifestations and Severity of falciparum and vivax Malaria Among Adults at Merowe City, Sudan 2021-2022

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DOI: 10.29322/IJSRP.16.09.2026.p17704
https://dx.doi.org/10.29322/IJSRP.16.09.2026.p17704

Paper Received Date: 25th July 2026
Paper Acceptance Date: 27th August 2026
Paper Publication Date: 8th September 2026

Abstract- Malaria is a significant health problem worldwide, especially in African countries like Sudan. It is caused by Plasmodium genus. There are five known species of Plasmodium to cause malaria in humans: P. falciparum, P. vivax, P. ovale, P. malariae, and P. knowlesi. Majority of cases are caused by Plasmodium falciparum and Plasmodium vivax. Plasmodium vivax is the most frequent cause of recurring malaria. It is less virulent than Plasmodium falciparum, but also it can lead to severe disease and death. Classic clinical signs and symptoms of malaria include fever, headache, nausea, vomiting, body aches, anemia, and jaundice. Malaria has many complications that are documented in both falciparum and vivax species. This comparative study investigates the prevalence, manifestations and severity of falciparum and vivax malaria among adults in 2 clinics of Merowe City, Sudan, in 2021-2022. A cross-sectional retrospective study was performed at AL-Gawda and Al-Ehsan Medical Clinics, in Merowe city, northern state, Sudan, from November 2021 to September 2022. All malaria-recorded cases that were above 18 years old were investigated and their lab results' recorded data of complete blood count, blood film for malaria, and Immuno-chromatographic test for detection of Plasmodium falciparum and Plasmodium vivax were collected. In this study, a total number of 149 malaria patients' records were found in the two clinics within the studied period of time, 67.1% were due to Plasmodium falciparum, while 32.9% were due to Plasmodium vivax. This study revealed that 57.1% of plasmodium vivax infected patients were male and 42.9% were female, while 53% of plasmodium falciparum infected patients were male and 47 % were female. 37% of vivax patients are in the age group of 31 to 40 yrs old, while majority of falciparum patients (35%) were between 41 to 60 yrs old. Fever and headache scored 16%, being the major vivax combined symptom, where common single presentation was fever for 18%, followed by headache for 10%. In plasmodium falciparum fever was documented in 29%, while fever and headache were found in 13%. 149 malaria patients' records were reported in Al Gawda and Al Ehsan medical clinics, Merowe, northern Sudan between November2021 and September 2022. Plasmodium falciparum was the major cause of malaria cases (67.1% and 53% of plasmodium falciparum). Vivax tents to infect the age group of 31-40 (37%), while 35% of falciparum patients were between 41 to 60 yrs old. Fever and headache scored 16%, being the major plasmodium vivax combined symptom, where common single presentation was fever for 18%, followed by headache for 10%. On the other hand, plasmodium falciparum showed a record of 29% for fever as the highest single symptom, and 13% for fever and headache as the major combined symptoms.

Index Terms- plasmodium falciparum, plasmodium vivax, malaria, Merowe, Sudan.

I. INTRODUCTION

Malaria is a significant health problem worldwide. In 2019 there were approximately 229 million cases of malaria responsible for about 409000 deaths, most of them were in Africa [1]. This disease is caused by *Plasmodium* genus. There are five species of Plasmodium are known to cause disease in humans: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae*, and *P. knowlesi*. Majority of cases are caused by *Plasmodium falciparum* and *Plasmodium vivax* [2].

Plasmodium vivax is the most frequent cause of recurring malaria (2). It is less virulent than Plasmodium falciparum, but also it can lead to severe disease and death [2].

P. vivax is carried by the female Anopheles mosquito. Incubation period for vivax malaria is 12 to 17 days, but relapses may occur up to 2 years later from dormant hypnozoites. Classic clinical signs and symptoms of malaria include fever, headache, nausea, vomiting, body aches, anemia, and jaundice [1].

Clinical pictures of P. vivax infection include asymptomatic parasitaemia, febrile illness, and severe malaria [3].

Severe P. vivax malaria may lead to severe anaemia (<5 mg haemoglobin/d), thrombocytopenia, acute pulmonary oedema, cerebral malaria, pancytopenia, jaundice, splenic rupture, haemoglobinuria, acute renal failure and shock.[3].

II. MATERIALS AND METHODS

Study Design, Area, and Period

A cross-sectional retrospective study was performed at two sites in Merowe city, found about 400 kilometers north to Khartoum the capital city of Sudan. The study was carried out from November 2021 to September 2022.

The study population was the records of all adult patients (above 18 years old) who had been confirmed to have malaria. Individuals with travelling history to Eastern Sudan excluded from the study due to epidemics of dengue fever which also is associated with thrombocytopenia.

Records of Complete Blood Count, Blood film for malaria, and Immuno-chromatographic test for detection of Plasmodium falciparum and Plasmodium vivax results that were done for all participants were recorded.

Following data collection, the data were analyzed using SPSS program

III. RESULTS

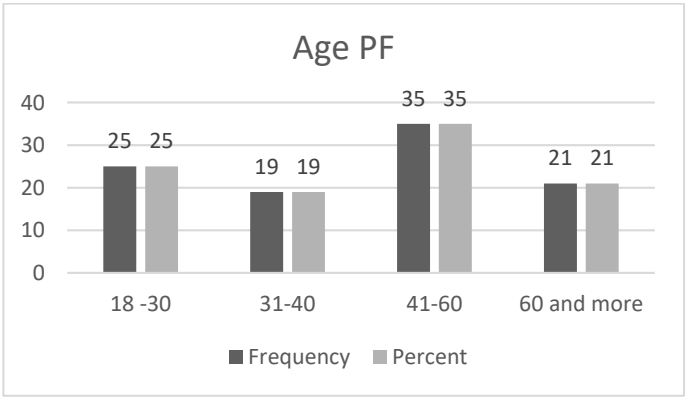
During the study period, 149 patients were diagnosed with malaria. All 149 records were examined

Out of 149 malaria cases, 100 Plasmodium falciparum-infected patients (77.1%) were due to plasmodium falciparum and 49 (32.9%) were due to plasmodium vivax.

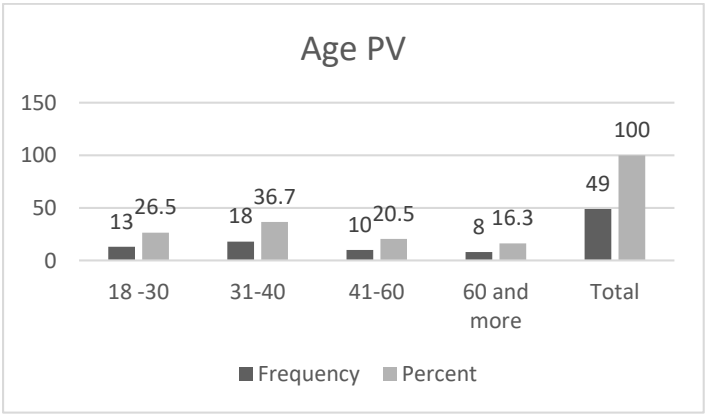
Table (1): Gender distribution of plasmodium falciparum and plasmodium vivax infected patients

	PF		PV	
	Frequency	**Percent**	**Frequency**	**Percent**
Female	47	47.0	21	43
Male	53	53.0	28	57
Total	100	100.0	49	100

Figure (1): Age distribution: (A) plasmodium falciparum, (B) plasmodium vivax



(A)



(B)

The study showed that most of patients have no comorbidities in both falciparum and vivax but diabetic patients were more in falciparum than vivax

Table (2): Comorbidities among (A) plasmodium falciparum, (B) plasmodium vivax

(A)

	Frequency	Percent
B.asthma	1	1.0
Celiac disease	1	1.0
CKD	1	1.0
Disc	1	1.0
Disc prolapse	1	1.0
DM	10	10.0
DM HTN	3	3.0
DM HTN AF	1	1.0
DM HTN IHD	1	1.0
DM HTN Stroke	1	1.0
Herpes zooster	1	1.0
HTN	15	15.0
Hypothyroidism	1	1.0
IHD	1	1.0
Migraine	1	1.0
No	58	58.0
Renal stone	2	2.0
Total	100	100.0

(B)

	Frequency	Percent
BPH	1	2.0
Ca Breast	1	2.0
Disc	1	2.0
DM	1	2.0
DM HTN	2	4.0
HTN	4	8.0
No	39	80.0
Total	49	100.0

Study found that 29% of falciparum patients present with fever alone copared to 18 % in vivax. Fever and headache in falciparum was 13% compared to 16% in vivax. Headache alone was more in vivax (10%) than in falciparum(7%). Abdominal pain and diarrhoea was more in falciparum (6%) than in vivax(2%) also loss of appetite in falciparum (10%) thn in vivax (8%)

Table (3): Presentation of (A) plasmodium falciparum, (B) plasmodium vivax

(A) Symptoms of PF

	Frequency	**Percent**
Abdominal pain	1	1.0
Abdominal pain, Diarrhoea	6	6.0
Abdominal pain, Diarrhoea, Vomitting, Loss	1	1.0
Abdominal pain, Vomitting	2	2.0
Diarrhoea	1	1.0
Diarrhoea, Vomitting	1	1.0
Fever	29	29.0
Fever, Abdominal pain	1	1.0
Fever, Diarrhoea, Loss of appetite	1	1.0
Fever, Headache	13	13.0
Fever, Headache, Abdominal pain, Vomitting	1	1.0
Fever, Headache, Loss of appetite	1	1.0
Fever, Headache, Vomitting	2	2.0

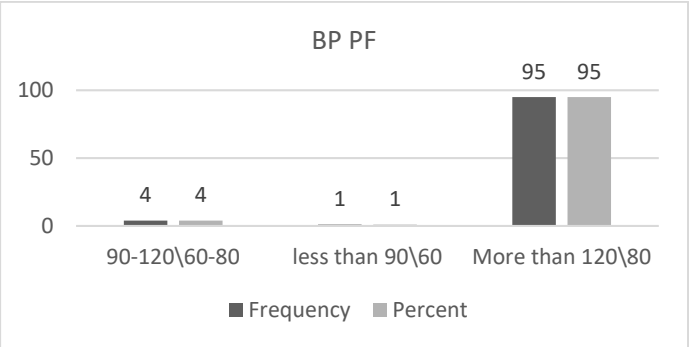
Fever, Loss of appetite	3	3.0
Fever, Rigors	2	2.0
Fever, Rigors, Abdominal pain	1	1.0
Fever, Rigors, Diarrhoea	1	1.0
Fever, Rigors, Headache, Vomitting	1	1.0
Fever, Rigors, Loss of appetite	1	1.0
Fever, Vomitting	1	1.0
Fever, Vomitting, Loss of appetite	1	1.0
Headache	7	7.0
Headache, Abdominal pain, Loss of appetite	1	1.0
Headache, Diarrhoea	1	1.0
Headache, Loss of appetite	3	3.0
Loss of appetite	10	10.0
Rigors, Loss of appetite	1	1.0
Vomitting	6	6.0
Total	100	100.0

(B) Symptoms PV

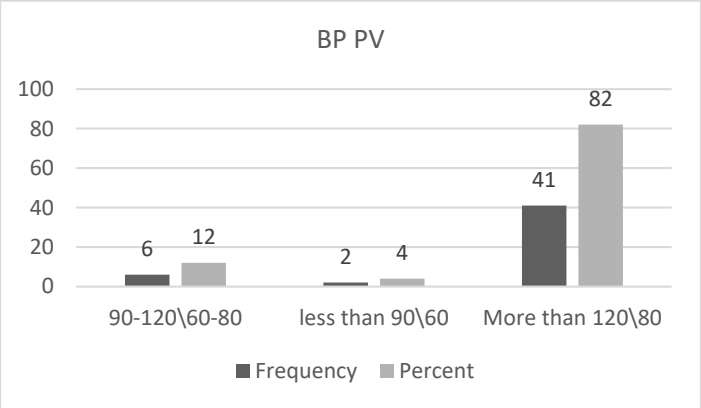
	Frequency	Percent
Abdominal pain	1	2.0
Abdominal pain, Diarrhoea	1	2.0
Abdominal pain, Diarrhoea, Vomitting	1	2.0
Fever	9	18.0
Fever, Abdominal pain	1	2.0
Fever, Confusion	1	2.0
Fever, Confusion, Loss of appetite	1	2.0
Fever, Diarrhoea, Vomitting	1	2.0
Fever, Headache	8	16.0
Fever, Headache, Loss of appetite	3	6.0
Fever, Headache, Vomitting	2	4.0
Fever, Headache, Vomitting, Loss of appetite	1	2.0
Fever, Rigors	1	2.0
Fever, Rigors, Abdominal pain, Vomitting	1	2.0
Fever, Rigors, Headache	2	4.0
Fever, Vomitting, Loss of appetite	1	2.0
Headache	5	10.0
Headache, Diarrhoea	1	2.0
Headache, Loss of appetite	1	2.0
Loss of appetite	4	8.0
Rigors, Abdominal pain	1	2.0
Rigors, Vomitting	1	2.0
Vomitting	1	2.0
Total	49	100.0

Blood pressure measurement showed that most of patents have normal or high BP but hypotension was more in vivax (12%) than in falciparum (1%)

Figure (2): Blood pressure measurement in (A) plasmodium falciparum, (B) plasmodium vivax



(A)



(B)

Study revealed one case of confusion associated with plasmodium vivax but no confusion was detected in plasmodium falciparum also neck stiffness was detected only in plasmodium vivax but not in falciparum

Table (4): Level of consciousness (GCS)

	PF		PV	
	Frequency	Percent	Frequency	Percent
13-14	0	0	1	2.0
15	100	100.0	48	96.0
Total	100	100.0	49	100.0

Table (5): Neck stiffness

	PF		PV	
	Frequency	Percent	Frequency	Percent
No	100	100	48	96.0
Yes	0	0	1	2.0
Total	100	100	49	100.0

Most cases had scanty parasitaemia. Hyperparasitaemia was found in 14% of plasmodium cases while was detected in 6 % of vivax cases

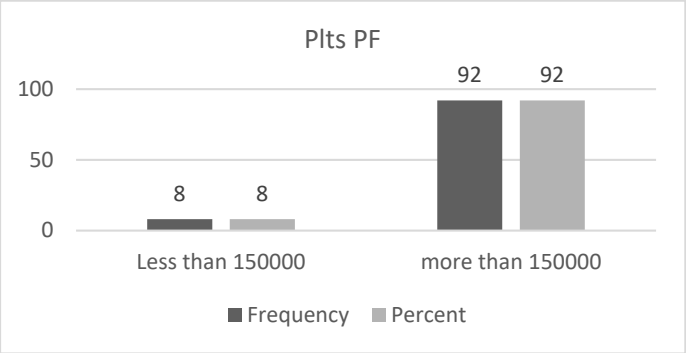
Table (6): Parasitaemia in plasmodium falciparum and plasmodium vivax

	PF		PV	
	Frequency	Percent	Frequency	Percent
+	74	74.0	42	85.7
++	12	12.0	4	8.2
+++	14	14.0	3	6.1
Total	100	100.0	49	100.0

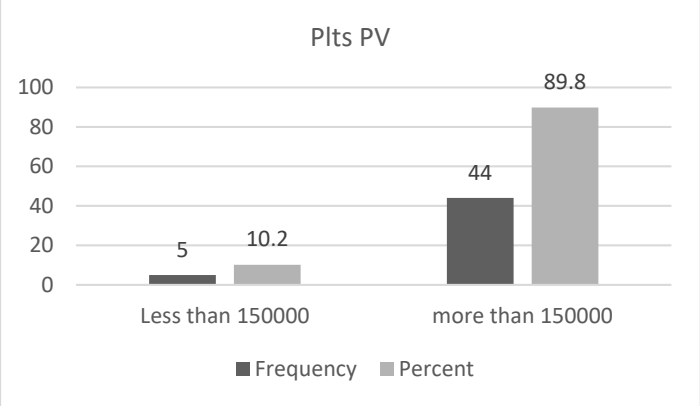
Study revealed thrombocytopenia in vivax (10%) more than falciparum (8%)

Figure (3): Thrombocytopenia in (A) plasmodium falciparum and (B) plasmodium vivax

(A)



(B)



Only one case of bleeding in vivax, while bleeding wasn't documented in falciparum and hypoglycemia occurred in 2% in plasmodium vivax compared to 1% of plasmodium falciparum cases.

IV. DISCUSSION

In this study, 149 malaria patients' records were examined, 77.1% were found to be due to Plasmodium falciparum, while 32.9% were due to Plasmodium vivax, which aligns with Makarim M Adam Suliman et al [4] results, who found plasmodium vivax in about 36% of malaria cases in central area of Sudan but of higher incidence to what he reported in Aljabaleen in white teNile state (20 %). This incidence of plasmodium vivax in this study is higher also in comparison to what Samwal Haj Osman et al [5] documentation, who report plasmodium vivax in about 2% of malaria cases in Elhajyousiff area (Khartoum State), but lower compared to K Saravu et al [6] findings; where 46 % of malaria patients were due to plasmodium vivax and Narendra Kumar Gupta et al [7], where 56% of malaria cases was due to plasmodium vivax, in India.

The present study revealed that 57% of plasmodium vivax infected patients were male and 43% were female, this male predominance aligns with Paulo Guilherme Souza Lisbôa et al [8], while 53% of plasmodium falciparum infected patients were male and 47 % were female. Most vivax patients (37%) are aged 31 to 40 yrs old, but most of falciparum patients (35%) were between 41 to 60 yrs old. In addition, 80% of vivax patients are free of comorbidities compared to 52% of falciparum patients.

In this study plasmodium vivax have various manifestations. Most common combined symptoms were fever and headache (16%), and most common single presentation was fever (18%), followed by headache (10%), these features are less than what documented by Paulo Guilherme Souza Lisbôa et al [8]. In current study also noticed that 17 patients did not mention fever as a presenting symptom. Compared to plasmodium falciparum fever as single complane, fever was documented in 29%, while fever and headache were found in 13%.

In the present study, plasmodium vivax present with many features of severe malaria (neck stiffness and confusion as cerebral malaria, 4%), (hypogylcaemia, 2%), (Thrombocytopenia, 10%), (hypotension, 4%), (hyperparasitaemia, 6%). This aligns with Maowia M Mukhtar et al [9] who reported a case of cerebral malaria and hyperparasitaemia due to plasmodium vivax in Al Kuwaiti hospital in Khartoum, also goes with Catalina Tovar-Acero et al [10] who reported that thrombocytopenia, hypoglycemia, and liver and kidney problems were the most common P. vivax malaria complications. Also goes with what Bilal Ahmad Rahimi et al [11] reported in a systematic review about 77 studies with severe plasmodium vivax. Plasmodium falciparum features of severe malaria were, (hypogylcaemia, 1%), (Thrombocytopenia, 8%), (hypotension, 1%), (hyperparasitaemia, 14%), neck stiffness, bleeding and confusion were not documented.

Manifestations of severe vivax malaria in this study have lower incidence with what reached by Tajeldin M Abdallah et al [12] who found severe plasmodium vivax in about 26% of 139 malaria patiens admitted to kassala hospital.

V. LIMITATIONS AND RECOMMENDATIONS

Study limitations were small sample size. We recommend performing a study with larger population and involving more centres for data collection with doing sepsis parameters.

VI. CONCLUSION

All cases of malaria in the present study were caused either by plasmodium falciparum or vivax, other species were not documentd. Male predominance had been noticed in both falciparum and vivax. Plasmodium vivax has been noticed as emerging cause of malaria and it presents with many clinical features, and also causes many complications, and it had been documented as one of causes of severe malaria. Many cases of vivax malaria were presented with features other than fever. Hypoglycaemia, hypotension and thrombocytopenia were documented in vivax more than falciparum, while fever and hyperparasitaemia were more in plasmodium falciparum

VII. ACKNOWLEDGMENT

We acknowledge AL-Gawda and Al-Ehsan medical clinics for providing the study with the decoded patients records.

REFERENCES

[1] WHO World Malaria Report 2020): WHO World Malaria Report 2020, World Malaria Report 2020

[2] Caraballo, H., & King, K. (2014). Emergency department management of mosquito-borne illness: Malaria, dengue, and West Nile virus. Emergency Medicine Practice, 16(5), 1–23.

[3] Menkin-Smith, L., Koval, K., & Samandari, T. (2026). Relapsing malaria. In StatPearls. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK538333/

[4] Suliman, M. M., Hamad, B. M., Albasheer, M. M., Elhadi, M., Amin Mustafa, M., Elobied, M., & Hamid, M. M. (2016). Molecular Evidence of High Proportion of Plasmodium vivax Malaria Infection in White Nile Area in Sudan. Journal of parasitology research, 2016, 2892371. https://doi.org/10.1155/2016/2892371

[5] Osman, S. H., Ali, S. S., Idris, A. A. A., Ahmed, R. M., Abdaltaif, A. M., Abdalla, E. K., Ali, M. M., Altaher, H. A. H. E., Ahmed, R. A. E., & Hassan, M. A. (2022). Prevalence of Plasmodium vivax species in Elhajyosife area in Shergalnile locality in Khartoum State. Microbes and Infectious Diseases, 3(2), 492–499. https://doi.org/10.21608/MID.2022.110280.1217J.

[6] Saravu, K., Docherla, M., Vasudev, A., & Shastry, B. A. (2011). Thrombocytopenia in vivax and falciparum malaria: an observational study of 131 patients in Karnataka, India. Annals of tropical medicine and parasitology, 105(8), 593–598. https://doi.org/10.1179/2047773211Y.0000000013

[7] Gupta, N. K., Bansal, S. B., Jain, U. C., & Sahare, K. (2013). Study of thrombocytopenia in patients of malaria. Tropical parasitology, 3(1), 58–61. https://doi.org/10.4103/2229-5070.113914

[8] Lisbôa, P. G. S., Medeiros, J. M. R., de Souza, A. V., Dos Santos, B. F. B., Sanches, H. O. C., da Rocha, J. L. G., Correa Junior, W. J. P., Costa, G. G., Chaves, T. D. S. S., da Silva Ventura, A. M. R., & Libonati, R. M. F. (2022). Analysis of malaria clinical-epidemiological predictors in individuals from Brazilian Amazon. Parasitology, 149(1), 10–14. https://doi.org/10.1017/S0031182021001165

[9] Mukhtar, M. M., Eisawi, O. A., Amanfo, S. A., Elamin, E. M., Imam, Z. S., Osman, F. M., & Hamed, M. E. (2019). Plasmodium vivax cerebral malaria in an adult patient in Sudan. Malaria journal, 18(1), 316. https://doi.org/10.1186/s12936-019-2961-1

[10] Tovar-Acero, C., Velasco, M. C., Avilés-Vergara, P. A., Ricardo-Caldera, D. M., Alvis, E. M., Ramirez-Montoya, J., & Yasnot Acosta, M. F. (2021). Liver and kidney dysfunction, hypoglycemia, and thrombocytopenia in Plasmodium vivax malaria patients at a Colombian Northwest region. Parasite epidemiology and control, 13, e00203. https://doi.org/10.1016/j.parepi.2021.e00203

[11] Rahimi, B. A., Thakkinstian, A., White, N. J., Sirivichayakul, C., Dondorp, A. M., & Chokejindachai, W. (2014). Severe vivax malaria: a systematic review and meta-analysis of clinical studies since 1900. Malaria journal, 13, 481. https://doi.org/10.1186/1475-2875-13-481

[12] Abdallah, T. M., Abdeen, M. T., Ahmed, I. S., Hamdan, H. Z., Magzoub, M., & Adam, I. (2013). Severe Plasmodium falciparum and Plasmodium vivax malaria among adults at Kassala Hospital, eastern Sudan. Malaria journal, 12, 148. https://doi.org/10.1186/1475-2875-12-148

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