

EPIDEMIOLOGY AND FACTORS OF MALARIA IN GHEBAISH TOWN, WEST KORDOFAN STATE, SUDAN. AN INSTITUTIONAL CROSS-SECTIONAL DESCRIPTIVE STUDY

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ABSTRACT

Background: Malaria remains one of the most important public health challenges in Sudan, particularly in endemic regions where environmental and socioeconomic factors favor continuous transmission. **Objective:** To determine the epidemiological patterns and associated risk factors of malaria among patients attending Ghebaish Hospital, West Kordofan State, Sudan. **Methods:** An institutional-based descriptive cross-sectional study was conducted in Ghebaish Town, West Kordofan State, Sudan, from December 2024 to February 2025. A total of 102 patients clinically suspected of malaria and attending or admitted to Ghebaish Hospital were enrolled. Sociodemographic and environmental data were collected using a structured questionnaire. Blood samples were obtained and examined microscopically using Giemsa-stained thick and thin blood films for malaria parasite detection and species identification. Data were analyzed using SPSS software.

Associations between malaria infection and potential risk factors were assessed using odds ratios (ORs), 95% confidence intervals (CIs), and Chi-square tests, with statistical

significance set at $p < 0.05$. **Results:** *Plasmodium falciparum* was the predominant species, accounting for 77.5% (79/102) of infections, followed by *Plasmodium vivax* (22.5%; 23/102). The highest proportions of participants were observed among the age groups 1–17 years and >33 years (28.4% each). Males constituted 52.9% of participants, while 61.8% resided in urban areas. Significant associations were found between malaria occurrence and age group, gender (OR=1.920; 95% CI: 1.464–2.519), residence (OR=1.575; 95% CI: 1.306–1.899), presence of water storage containers (OR=0.060; 95% CI: 0.025–0.139), and trees or grasses surrounding households (OR=1.451; 95% CI: 1.245–1.691) ($p < 0.001$). **Conclusion:** *P. falciparum* was the predominant malaria species in Ghebaish Town. Demographic and environmental factors significantly influenced malaria transmission. Strengthening vector control measures, environmental management, and community health education is recommended to reduce malaria burden in the study area.

KEYWORDS: Malaria, Epidemiology, Risk Factors, *P. falciparum*, *P. vivax*, Sudan, West Kordofa.

INTRODUCTION

Malaria is one of the leading causes of illness and death and the world's most prevalent vector-borne disease.^[1,2] Overall, 90% of these deaths occur in sub-Saharan Africa, and the rest happen in Latin America and Asia. Although has been greatly reduced globally.^[3] Malaria remains a main contributor to morbidity and mortality. In Sudan, malaria is a major health problem. The entire population is at risk of malaria epidemics with a very high burden on government and population.^[4] According to the latest data, in 2016, about 37 million people were at risk of the disease and an estimated of 4000 deaths occurred.^[5] *P. falciparum* is responsible for approximately more than 90% of cases.^[6,7]

Climatic variability is thought to have a direct impact on the epidemiology of many vector-borne diseases.^[8] It plays an important role in the transmission of malaria.^[9] In particular; temperature, rainfall, and relative humidity are the most important variables in creating suitable conditions for malaria transmission. Temperature also plays a key role in malaria transmission as it regulates the development of mosquito larvae and affects the growth from egg to adult mosquito, even parasites.^[10,11] Rainfall also creates suitable conditions that allow sufficient surface water for mosquito breeding sites. Relative humidity also affects the survival rate of mosquitoes, as they cannot complete their transmission cycle under relative humidity less than 60%.^[11] Floods may also lead to an increase in vector-borne diseases

through the expansion in the number and range of vector habitats. Malaria epidemics in the wake of flooding are a well-known phenomenon in malaria-endemic areas worldwide.^[12] This is especially true in Sudan where epidemic outbreaks have occurred along the Blue Nile River margins.^[13] The malaria epidemic in South Kordofan (2018–2019) reported a sudden rise in malaria cases. The recurrent nature of malaria epidemics in Sudan suggests insufficient control measures and ongoing transmission cycles. Furthermore, research conducted in Shendi, Sudan (2019–2020) found that more than two-thirds of malaria patients were diagnosed with the disease, reinforcing the high endemicity of malaria in Sudanese localities.^[14]

MATERIAL AND METHODS

2.1 Study design

An institutional-based descriptive cross-sectional study was conducted to investigate the epidemiological characteristics and associated factors of malaria among patients attending Ghebaish Hospital in West Kordofan State, Sudan.

2.2 Study area

The study was conducted in Ghebaish Town, located in West Kordofan State, western Sudan. Ghebaish is situated approximately 110 km southwest of El Fula, the capital of West Kordofan State. The area is characterized by a semi-arid climate with a distinct rainy season extending from June to October. Seasonal rainfall creates numerous temporary breeding sites for *Anopheles mosquitoes*, the principal vectors of malaria. The population mainly depends on agriculture, livestock rearing, and small-scale trading. Malaria transmission in the area is seasonal but remains a major public health concern due to favorable environmental conditions and limited vector-control coverage.^[15,16]

2.3 Study population

The study population consisted of all patients attending outpatient departments or admitted to Ghebaish Hospital during the study period and clinically suspected of having malaria.

2.3.1 Inclusion Criteria

- Patients of all ages and both sexes attending or admitted to Ghebaish Hospital.
- Patients presenting with signs and symptoms suggestive of malaria,
- Patients willing to participate and provide informed consent (or assent from guardians for minors).

2.3.2 Exclusion Criteria

- Patients who declined participation.
- Patients currently receiving antimalarial treatment before sample collection.
- Patients with incomplete questionnaire information or inadequate blood specimens

2.4 Sampling and Sample Techniques

A consecutive sampling technique was employed whereby all eligible patients presenting during the study period were recruited until the required sample size was attained.

2.4 Study variables

2.4.1 Dependent Variable

Malaria infection status (positive/negative) and malaria parasite species (*P. falciparum* or *P. vivax*)

2.4.2 Independent Variables

2.4.2.1 Socio-demographic Variables; are consist age, gender, residence (urban/rural), occupation, educational status.

2.4.2.2 Environmental Variables; are include presence of water storage containers around the house, presence of stagnant water, presence of trees or grasses near the house, and household environmental sanitation.

2.4.2.3 Behavioral Variables; such as use of insecticide-treated bed nets (ITNs).

2.5 Data collection

2.5.1 Procedure of data collection

After obtaining informed consent, capillary blood samples were collected aseptically by finger-prick using sterile disposable lancets.

○ Preparation of Blood Films

Two blood smears were prepared from each participant:

- Thick blood film: used for parasite detection and estimation of parasite density. Approximately 6–10 μL of blood was spread in a circular area.^[17,18]
- Thin blood film: used for species identification. A small blood drop was spread to form a feathered edge.^[17,19]

○ Staining Procedure

The blood films were air-dried and stained using 10% Giemsa stain for 10 minutes according to standard WHO protocols.

○ Microscopic Examination:

Slides were examined under a binocular light microscope using.^[20,21]

- Objective lens: ×100 oil immersion
- Eyepiece: ×10
- Total magnification: ×1000

Each slide was independently examined by experienced laboratory technologists. A slide was considered negative only after examination of at least 100 high-power microscopic fields without detection of malaria parasites.

2.5.2 Data Collection Tools

2.5.2.1 Structured Questionnaire

A pre-tested structured questionnaire was administered to collect information regarding: socio-demographic characteristics, environmental conditions, and behavioral risk factors.

2.5.2.2 Light Microscope

A standard laboratory binocular light microscope equipped with

- Mechanical stage
- Adjustable condenser
- Oil immersion objective lens (100×)
- Built-in illumination system was used for malaria parasite detection and species identification.

2.6 Data processing and analysis

All data was entered, processed and analyzed using statistical package for social sciences (SPSS), and Microsoft excel software (2015).

3. RESULTS

This is a descriptive cross sectional study and it was conducted in Ghebaish town, West Kordo fan State, during the period from December 2024 to February 2025. The samples and data must be collected from the patients who are visited or admitted to the hospital. Fig. 1 illustrates that high infections of parasite is found in *P. falciparum* (79/77.5%) and *P. vivax*.

(23/25.5%), with mean = 1.2255 and standard deviation (SD) = 0.41997. It showed that the age groups of participants were < one year, 1 - 17 yrs., 18 – 33 yrs., and > 33 yrs. with (21/20.6%), (29/28.4%), (23/22.5%) and (29/28.4%), respectively; (see table 1). Fig. 2 showed that (54/52.9%) of patients were male and (48/47.1%) were female. Fig. 3 shows that (39/38.2%) of patients from rural area and (63/61.8%) from urban area. According to table (2), the factors related patterns of malaria disease include age group, gender, residence, containers for storing water and trees or grasses near to house, with (p<0.000), “p<0.000; (OR=1.920; 95% CI (1.464 – 2.519)”, “p<0.000; (OR=1.575; 95% CI (1.306 – 1.899)”, “p<0.000; (OR=0.060; 95% CI (0.025 – 0.139)”, “p<0.000; (OR=1.622; 95% CI (1.328 – 1.980)” and “p<0.001; (OR=1.451; 95% CI (1.245 – 1.691)”.

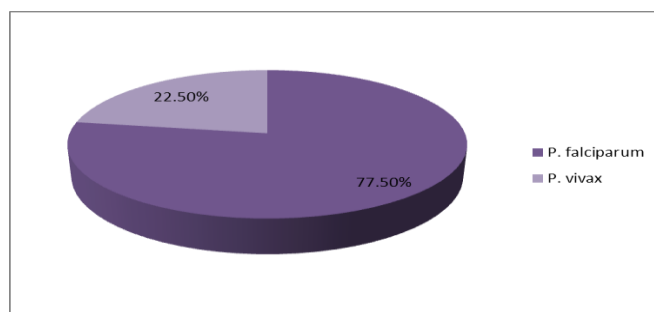


Fig. 1: Distribution of participants according to etiological diagnosis, Ghebaish Town; (n= 102).

Table 1: Distribution of participants according to age group, Ghebaish Town; (n= 102).

Malaria cases	Frequency	Percent
< one year	21	20.6%
1 - 17 yrs.	29	28.4%
18 – 33 yrs.	23	22.5%
> 33 yrs.	29	28.4%
Total	102	100%



Fig. 2: Distribution of participants according to gender, Ghebaish Town; (n= 102).

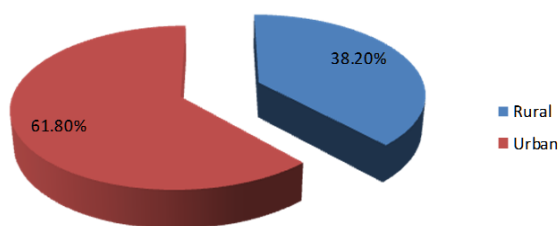


Fig. 3: Distribution of participants according to residence, Ghebaish Town; (n= 102).

Table (2): Risk factors related patterns of malaria in Gubaish Town; (n= 102).

Factors	Types of plasmodium		Total	OR	95% CI		p-value
	P. falciparum	P. vivax			Lower	Upper	
Age group (n= 102)							
<one year	16.3	4.7	21/20%	-	-	-	<0.000
1-17 yrs.	22.5	6.5	29/28.4%				
18-33 yrs.	17.8	5.2	23/22.5%				
> 33	22.5	6.5	29/28.4%				
Gender (n= 102)							
Male	41.8	12.2	54/52.9%	1.920	1.464	2.519	<0.000
Female	37.2	10.8	48/47.1%				
Residence (n= 102)							
Rural	30.2	8.8	39/38.2%	1.575	1.306	1.899	<0.000
Urban	48.8	14.2	63/61.8%				
Do you have containers for storing water? (n= 102)							
Yes	65.1	18.9	84/82.4%	0.060	0.025	0.139	<0.000
No	13.9	4.1	18/17.6%				
Are there any trees or grasses near to house? (n= 102)							
Yes	32.5	9.5	42/40.2%	1.622	1.328	1.980	<0.000
No	46.5	13.5	60/59.8%				
Do you use mosquito net? (n= 102)							
Yes	21.7	6.3	28/27.5%	1.451	1.245	1.691	<0.001
No	57.3	16.7	74/72.5%				

DISCUSSION

Malaria remains a significant public health burden, particularly in Sudan, where both *Plasmodium falciparum* and *Plasmodium vivax* contribute to morbidity and mortality. The present descriptive cross-sectional study conducted in Ghebaish Town during December 2024 and February 2025 aimed to study the patterns and factors related malaria among participants visiting or admitted to hospital. The findings provide crucial insights into the epidemiological distribution of malaria infections, factors, and possible intervention strategies.

This present indicated that *P. falciparum* was the dominant malaria parasite, (79/77.5%), whereas *P. vivax* was (23/25.5%). This aligns with previous research in Sudan and Ethiopia, which reported *P. falciparum* as the predominant malaria species in endemic regions.^[22,25] However, the rising incidence of *P. vivax* malaria in Sudan has been reported in recent years, as observed by Elgoraish *et al.* (2019), where *P. vivax* constituted 26.6% of malaria cases in different Sudanese states.^[25] The mean prevalence of *P. falciparum* infections in the present study was 1.2 with a standard deviation (SD) of 0.4, indicating relatively low variation within the studied population.

The study found malaria cases distributed across all age groups, with the highest prevalence among individuals aged 1–17 years (29%), followed by those above 33 years (27%), 18–33 years (23%), and infants under one year (21%). This trend is consistent with previous research conducted in South Kordofan, Sudan, which reported a high burden of malaria infections among children and young adults.^[22] However, the study by Singh *et al.* (2019) in India found that mortality was highest in the 21–30-year age group (38.46%), followed by the 11–20-year group (23.08%).^[24] The age-related vulnerability observed in both studies emphasizes the need for targeted malaria control strategies for younger populations in endemic regions.

The present study reported a higher prevalence of malaria among males (54/52.9%) “ $p < 0.000$; (OR=1.920; 95% CI (1.464 – 2.519))”. This male predominance in malaria infections aligns with findings from Gerensea and Teklay (2017), who analyzed malaria morbidity trends in Ethiopia and found that males were disproportionately affected.^[22] Additionally, Singh *et al.* (2019) reported a male-to-female mortality ratio of 3:1 in malaria-related deaths, suggesting that biological, occupational, or behavioral factors might contribute to increased malaria exposure among men.^[24]

The study also examined the residence status was associated with malaria, revealing that (63/61/8%) of cases were from urban areas, whereas (39/38.2%) were from rural areas; (OR=1.575; 95% CI (1.306 – 1.899))”. This differs from the common assumption that malaria is predominantly a rural disease, indicating that urban transmission may be increasing due to environmental and socio-economic factors. In contrast, Elgoraish *et al.* (2019) highlighted significant variations in malaria prevalence between different Sudanese states, where rural populations showed higher malaria infection rates due to transmission stability.^[26]

The current study showed that containers for storing water was associated with prevalence of malaria disease “ $p < 0.000$; (OR=1.622; 95% CI (1.328 – 1.980))”. Stagnant water storage has long been recognized as a key risk factor for malaria transmission, providing ideal breeding grounds for *Anopheles* mosquitoes. Studies in sub-Saharan Africa have consistently linked water storage habits to increased malaria transmission, emphasizing the need for improved water management and vector control strategies.^[23]

The findings indicated that trees and grasses around their homes (41.2%) associated with malaria disease; “ $p < 0.000$; (OR=1.622; 95% CI (1.328 – 1.980))”. The presence of vegetation and dense foliage has been associated with higher mosquito breeding rates, particularly in urban and peri-urban settings. The previous studies, demonstrated that malaria incidence varied significantly based on environmental factors, with fluctuations observed over time due to changing ecological conditions.^[25] Research by Maigemu and Hassan (2015) highlighted a strong correlation between malaria incidence and socio-economic status, with higher malaria mortality rates in low-income populations.^[23]

Alarming, 27.5% of patients did not use bed nets and it associated with malaria; “ $p < 0.001$; (OR=1.451; 95% CI (1.245 – 1.691))”. This low utilization of insecticide-treated bed nets (ITNs) is concerning, as bed nets are one of the most effective malaria prevention strategies. The study findings are consistent with Jha et al. (2020), who reported a 41.31% reduction in malaria-related disability-adjusted life years (DALYs) in India due to the widespread use of ITNs and malaria control programs.^[24] Increasing bed net distribution and community awareness campaigns is crucial to reducing malaria transmission.

CONCLUSION

The findings revealed statistically significant associations between malaria occurrence and several demographic and environmental factors, including age group, gender, place of residence, the presence of water storage containers, and the existence of trees or grasses surrounding households.

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ETHICAL CONSIDERATIONS

Ethical approval was obtained from the relevant Institutional Review Board (IRB) and the administration of Ghebaish Hospital. Permission was obtained from local health authorities before commencement of the study. Verbal informed consent was secured from all participants, while consent was obtained from parents or guardians of minors. Confidentiality was maintained throughout the study by using coded identifiers instead of personal information. Participants diagnosed with malaria were referred for appropriate treatment according to the Sudan National Malaria Control Programme guidelines and World Health Organization recommendations.

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