CLINICAL RESEARCH

Prevalence of Malaria Parasite Infection in Alhelaliya Hospital Gezira State Sudan

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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, it was estimated 7.5 million morbidity cases occurring annually and more than 35,000 deaths, most of these are children and pregnant women. Therefore, the study aimed to assess prevalence of malaria infection in a Alhelaliya hospital-Gezira state.

METHODS

A cross-sectional study was conducted to estimate malaria prevalence among the population in Alhelaliya hospital Al-Gezira state, Sudan. A total of 500 patients with suspected malaria were recruited for this study between September and October 2023. Microscopic diagnosis for thick and thin blood films were performed to detect the Plasmodium species and parasite count.

RESULTS

Out of 500 patients (231 males and 269 females), 211 were positive for malaria, with high prevalence of *P. falciparum* infection (98.1%) than *P. vivax* infection (1.9%), with p-value was 0.001. Among infected patients, 131 has low parasitaemia (+),74 patients with moderate parasitaemia (++) and 6 with high parasitaemia 5 (+++) and one patient (++++), The frequency of infection across ages of the population is the same.

CONCLUSION

In this study prevalence of malaria in Alhelaliya hospital had a significant a higher proportion of low parasitaemia. To eradicate the impact of malaria at all, the local government and other concerned organizations should put more emphasis on routine insecticide-treated net (ITN) use, infections linked to nighttime exposure to the outdoors, environmental management, and modification of attitudes toward malaria prevention and control through health education.

KEYWORDS

Prevalence; Malaria in Sudan; Malaria infection; Alhelaliya city; Al-Gezira state

ABBREVIATION

RDT: Rapid Diagnosis Test; ACT: Artemisinin-based Combination Therapy; WHO: World Health Organization; ICT: Immune-Chromatographic Test; SPSS: Statistical Package for Social Sciences; *P. vivax*: *Plasmodium Vivax*; *P. falciparum*: *Plasmodium Falciparum*; ITN: Insecticide-treated Net

INTRODUCTION

Malaria is a serious vector-borne tropical disease that remains one of the primary reasons for death in several developing countries [1], it remains global public health problem. Globally, in 2021, the region accounted for 95% of all malaria cases (234 million cases); 96% of all malaria deaths (593,000 deaths); and nearly 80% of all malaria deaths were among children under the age of 5 [2]. The African region continues to shoulder the heaviest burden of malaria. In 2021, the Eastern Mediterranean Region's seven malaria-endemic countries accounted for 2.5% of global malaria cases. Sudan carried the heaviest malaria burden in the region, accounting for 54% of cases, followed by Somalia, Yemen, Pakistan, Afghanistan, and Djibouti. The total malaria deaths were reduced by about 45%, from 13,600 in 2000 to 7500 in 2014, and then increased by 79%, reaching 13,400 in 2021. Most of these deaths were observed in Sudan, although increases were also seen in Djibouti and Somalia [2].

In Sudan, the peak months of malaria transmission are from September to November. However, in Gezira State, there is an additional peak by the end of February, which corresponds to the end of the irrigation season when small pools of water form along the drying canals with a subsequent increase in mosquito density. Furthermore, the development of drug resistance to the malarial parasite is a major threat to malaria control programs in Sudan. Some surveys have reported the failure of artemisinin-based combination therapy (ACT) to treat uncomplicated malaria in Sudan, and a high prevalence of mutations in *P. falciparum* drug resistance genes was detected [3].

Since 2010, it has been recommended by the World Health Organization (WHO) that all suspected malaria cases be confirmed with either microscopy for parasitaemia counting or RDT in all clinical settings. In the case of malaria, the plasmodium parasite within the erythrocyte can be observed by microscopic observation. Nowadays, the widespread reference method to diagnose malaria under a microscope is a thin and thick blood smear using Giemsa stain. This method remains the gold standard used to quantify and stage malaria parasites [4].

The prevalence correlates with age, as children are three times more likely to get malaria than adults. Apparently, there was no difference between males and females. Similarly, the lowest economic class is at higher risk.

Internally displaced people and refugee camps reported a prevalence that doubled that in rural areas and was three times higher than that in urban areas [5].

MATERIALS AND METHODS

Study Setting and Duration

This study was conducted in Alhelaliya hospital which is located in Alhelaliya city east of Gezira State, South of Khartoum. A total of 500 patients were recruited for this study between September and October 2023.

Study Design and Population

This study was a cross-sectional study that recruited patients presenting clinical symptoms of malaria and visiting the Alhelaliya hospital in the study site.

Sample Size Calculation

The sample size was estimated Using Cochran's formula:

$n = z^2 \times (p) \times (1 - p) \div e^2$

n = sample size

z = Z score =1.96

P = prevalence (0.5)

e = margin of error

n = 385, sample size of 385 was calculated using a prevalence (p) of ..., 5% margin error (e), 95% confidence interval (Z) given as 1.96 and 5% attrition.

A total of 500 samples were collected for this study from Alhelaliya teaching hospital to increase accuracy.

Data Collection

People attending Alhelaliya hospital were approached to participate in the study. Questionnaires were administered by medical doctors that requesting demographic information on (age and gender), main signs, symptoms of malaria (fever, headache), then blood sample obtained by professional laboratory staff.

Laboratory Methods
Preparation of thick film

Collection of finger - prick blood sample on a clean and grease free glass slide, thick film was made by spreading one drop of blood with a slide evenly on an area about 15 mm × 15 mm in diameter. Then, the slide was labeled properly and allowed to air-dry by keeping the slide on horizontal position. Precaution was taken during spreading and drying [6].

Preparation of thin film

After collection of one drop of blood on a clean grease free slide at the same slide contain thick film, thin film was made by spreading the blood using a smooth-edged slide or spreader at an angle of 45º from the horizontal plane. A well-prepared thin blood film was judged by having a smooth tail end and free of vertical lines and holes. The slide was allowed to air- dry. Absolute methanol was used to fix the thin film, slide was allowed 1 minute - 2 minutes to fix [6].

Staining blood films

The slide was first placed on a staining rack. Then 10% Giemsa stain having a pH of 7.2 was poured gently on the slide contain fixed thin film and thick film until the slide was totally covered. Then the slide was allowed to stain for 10 minutes out of the sunlight. Then the stain was washed with clean water. Back of the slide was wiped and placed in a draining rack. The slide was then allowed for air dry [6].

Diagnosis by microscopy using thick and thin blood film

The thick and thin blood films were examined using $100 \times$ magnifications, The thick blood smear samples were first examined for the presence of plasmodium parasites to determine whether the sample is positive or negative. When samples were positive, determination of parasitaemia from thick film, thin blood smears were examined for species identification [6].

The Quality Controls

All microscopes were checked. New and clean blood lancet, slides, and oil were used, and care was taken with slide labelling.

Ethical clearance

The study received ethical clearance was obtain from the of Alhelaliya hospital, informed and consent permission from each participant was obtained prior to their participant in the study also the study data/information was used for the research purposes only. The privacy issues intentionally are considered.

Data analysis

Relevant data were analyzed statistically using the computer program, statistical package for social sciences (SPSS), version 20, the descriptive statistics and chi-square tests was done.

RESULTS

Out of the 500 blood samples examined for presence of malaria parasite, 211 villagers were found to harbour malaria parasite in their blood, this constituted an overall prevalence of 42.4% as shown in (Table 1).

		Frequency	Percent
Valid	Malaria Parasite Seen	211	42.20%
	No Malaria Parasite Seen	289	57.80%
	Total	500	100%
P-value		0.001	

Table 1: Frequency of malaria infection among entire population.

Regarding the prevalence of malaria parasitic infection among the villagers using blood film microscopy, *plasmodium falciparum* was designated as the most dominant as it found in 207(98.1%) of total positive cases, followed by the plasmodium vivax 4(1.9%), most of the cases were single infection as shown in (Table 2).

Blood Film Test Result * Type of Plasmodium Species Crosstabulation					
			Type of Plasmodium Species		**Total**
			Plasmodium Falciparum	*Plasmodium Vivax*	
Blood Film	**Malaria Parasite Seen**	**Count**	207	4	211
		% of Total	98.10%	1.90%	100.00%
Total		**Count**	207	4	211
		% of Total	98.10%	1.90%	100.00%
P-value		**Count**			0

Table 2: Frequency of malaria infection according to species.

As shown in table 3, the prevalence of malaria parasite in the male group (20.8%), (8%) in pregnant female and (20.6%) in non-pregnant female. This difference was found to be statistically insignificant p-value = 0.24.

Blood Film * Gender Cross Tabulation						
				Gender		Total
			Male	Female Pregnant	Female Non-Pregnant	
Blood Film	Malaria Parasite Seen	Count	104	4	103	211
		% of Total	20.80%	0.80%	20.60%	42.20%
	No Malaria Parasite Seen	Count	127	4	158	289
		% of Total	25.40%	0.80%	31.60%	57.80%
Total		Count	231	8	261	500
		% of Total	46.20%	1.60%	52.20%	100.00%
P-value		Count	0.41			

Table 3: Frequency of malaria infection according to gender.

As shown as in table 4, the highest prevalence rate of malaria parasite infection (56) was found among those aged ranged from 21 years to 40 years, while This difference was found to be statistically insignificant p-value = 0.24.

Age * Blood Film Cross Tabulation					
			Blood Film		Total
			Malaria Parasite Seen	No Malaria Parasite Seen	
Age	Day to 5 Years	Count	40	46	86
		% of Total	8.00%	9.20%	17.20%
	from 6 Years to 10 Years	Count	24	25	49
		% of Total	4.80%	5.00%	9.80%
	from 11 Years to 20 Years	Count	53	56	109
		% of Total	10.60%	11.20%	21.80%
	from 21 Years to 40 Years	Count	56	100	156
		% of Total	11.20%	20.00%	31.20%
	from 41 Years to 60 Years	Count	24	39	63
		% of Total	4.80%	7.80%	12.60%
	from 61 Years to 100 Years	Count	14	23	37
		% of Total	2.80%	4.60%	7.40%
Total		Count	211	289	500
		% of Total	42.20%	57.80%	100.00%
P-value		Count	0.24		

Table 4: Frequency of malaria infection according to age group.

In parasite density among infected patient, it was noted that 131 patients have low parasitaemia (+) followed by 74 patients (++), 5patients with parasite density (+++) and one patient has (++++) as shown in (Table 5).

		Frequency	Percent
Valid	+	131	26.20%
	++	74	14.80%
	+++	5	1.00%
	++++	1	0.20%
	Non	289	57.80%
	Total	500	100%

Table 5: Frequency of malaria infection according to parasite density.

Clinical Features * Blood Film Cross Tabulation					
			Blood Film		Total
			Malaria Parasite Seen	No Malaria Parasite Seen	
Fever	Yes	Count	188	236	424
		% of Total	37.60%	47.20%	84.80%
	No	Count	23	53	76
		% of Total	4.60%	10.60%	15.20%
Fatigue	Yes	Count	209	282	491
		% of Total	41.80%	56.40%	98.20%
	No	Count	2	7	9
		% of Total	0.40%	1.40%	1.80%
Headache	Yes	Count	174	228	402
		% of Total	34.80%	45.60%	80.40%
	No	Count	37	61	98
		% of Total	7.40%	12.20%	19.60%

Table 6: Frequency of malaria infection according to clinical features of population.

As shown in table 6, the prevalence of malaria parasite is (37.6%) in patients who complain from fever, (41.8%) who complain from fatigue and (34.8%) from headache.

As shown in Table 7, 25 of the patients using insecticides were infected with the malaria parasite, and 57 of those who were under mosquito nets were infected with the malaria parasite.

Uses of Insecticide & Sleeping under Nets * Blood Film Test Result Crosstabulation				
		Blood Film		**Total**
		Malaria Parasite Seen	**No Malaria Parasite Seen**	
Use of Insecticide	**Yes**	25	31	56
	No	186	258	444
Sleeping	**Yes**	57	78	135
Under Nets	**No**	154	211	365

Table 7: Frequency of malaria infection according to uses of protective tools.

DISCUSSION

This study was carried out in an area characterized by seasonal and unstable malaria transmission. The results show that prevalence of malaria infection is (42.2%) in Alhelaliya city Al-Gezira State, the most remarkable result in this study was the unexpected high proportion of *P. falciparum* (98.1%) infections among suspected malaria The main malaria transmission peak for *P. falciparum* occurs in July and early November, just after the rainy season, and a second, less severe peak occurs in December to early February. Contrarily, P. vivax transmission peaks primarily between March and May, following the P. falciparum winter peak. During the rainy season, *P. vivax* transmission experiences a second intense peak that lasts less time than the comparable peak in *P. falciparum*. There are six distinct malaria epidemiological strata in Sudan, according to the Ministry of Health. These include malaria in seasonal, riverine, irrigated, urban, emergency, and conflict zones [7].

The WHO's malaria control and elimination strategies state that access to all interventions, such as improved case management, increased ITN use, IRS, early diagnosis and treatment, and environmental management, helps reduce malaria [8] (49) preventing malaria in developing countries [9].

CONCLUSION

In light of the comprehensive analysis conducted in Alhelaliya city, Al-Gezira State, the following conclusions are drawn:

- The study found a prevalence rate of 42.2% for malaria infection in Alhelaliya city, Al-Gezira State.
- The most dominant of malaria parasite species among the cases were *P. falciparum*.
- The local governments must make more effort to fully use and disseminate protective tools and increase environmental hygienic measures through educational programmes to completely eliminate malaria parasite.

ACKNOWLEDGEMENTS

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DATA AVAILABILITY

All data generated or analyzed during this study are available within the manuscript and will be made available for public access upon request without any restrictions.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study received ethical clearance from the Ethics Committee of Alhelaliya Teaching Hospital. Informed consent was obtained from all participants before their inclusion in the study. All data collected was utilized solely for research purposes, with utmost consideration for participant privacy.

CONSENT FOR PUBLICATION

Not applicable.

COMPETING INTERESTS

The authors declare no competing interests.

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