Water Source and its Relation with Vector of Malaria and Parasite in Elobied, North Kordofan State, Sudan

Fathi Elhag, Mohamed Salih and Mona Salih

Biology Department, Faculty of Science and Arts in Almakhwah, Al-Baha University, Saudi Arabia

ABSTRACT

A survey was carried out using specially designed questionnaire in Elobied, North Kordofan state, Sudan to evaluate the presence of the vector of malaria and parasite. **Results:** showed that (87.1%) storing water for week (9.4%) storing water for more than a week. Out of 170 interviewed121 (71.1%) report that mosquito bite the main factor for causing malaria (11.1%) unhygienic surrounding, (5.2%) others. **Conclusion:** It was observed that the continuous artificial breeding sites may be suitable places for breeding *Anopheles arabiensis*, the main vector of malaria in the town. Most of the respondents associated mosquito bite with malaria transmission.

Keywords: Malaria, *Plasmodim falciparum, Anopheles arabiensis,* Mosquitoes, Sudan

1. Introduction

Malaria infection is transmitted by anopheline mosquitoes and is caused by two species of protozoans, *Plasmodium falciparum* and *P. vivax. Plasmodium falciparum* is potentially lethal, whilst. *P. vivax* is more benign (Steve *et al.,* 2004). The World Health Organization (WHO, 2017) estimates that there are about 300–500 million clinical malaria cases annually and that 1–1.5 million people die of malaria each year. In 2017, there were an estimated 219 million cases of malaria in 87 countries. The estimated number of malaria deaths stood at 435 000 in 2017.The WHO African Region carries a disproportionately high share of the global malaria burden. In 2017, the region was home to 92% of malaria cases and 93% of malaria deaths**.** Fifteen countries in sub-Saharan Africa and India carried almost 80% of the global malaria burden. Five countries accounted for nearly half of all malaria cases.

Worldwide: Nigeria (25%), Democratic Republic of the Congo (11%), Mozambique (5%), India (4%) and Uganda (4%). The 10 highest burden countries in Africa reported increases in cases of malaria in 2017 compared with 2016. Of these, Nigeria, Madagascar and the Democratic Republic of the Congo had the highest estimated increases, all greater than half a million cases. In contrast, India reported 3 million fewer cases in the same period, a 24% decrease compared with 2016 (WHO, 2018). *Anopheles arabiensis* and *Anopheles gambiae* are the principal vectors of malaria in sub-Saharan Africa, but in some areas, such as the Great Rift Valley in East Africa, *A. arabiensis* is the predominant malaria vector species (Minakawa *et al.,* 2002). *A. arabiensis* is better adapted to dry environments than *A. gambiae* (Lindsay *et al.,*1998). The diagnosis and management of malaria, especially falciparum malaria, is urgent. As signs and symptoms of malaria are very non-specific, a high index of suspicion is the most important element in the diagnosis of malaria (Global Health, 2018). Malaria should be suspected in any person presenting with any of the symptoms listed below, who has a history of travel to, or residence in, a malaria transmission area. Delayed diagnosis, underassessment of disease severity and inappropriate treatment are associated with significantly increased morbidity and mortality. Classically, malaria presents fever, rigors, headache, and body pains, but the clinical features are non-specific and may be confused with many other diseases, especially influenza (Global Health,2019). A definitive diagnosis should be made promptly by demonstrating the parasite on microscopy of a blood smear or by using a malaria rapid diagnostic test. Disease severity should be assessed carefully with both clinical and laboratory tests (WHO, 2019). Antimalarial treatment studies have also contributed insight

Corresponding Author: Fathi Elhag, Biology Department, Faculty of Science and Arts in Almakhwah, Al-Baha University, Saudi Arabia. E-mail: fathi.elhag@yahoo.com

regarding mixed Plasmodium species infections by revealing undocumented infection of a second species following successful treatment of a first species (Zimmerman *et al.,* 2004). Malaria is a significant health problem in Sudan, affecting 52% of outpatients accounting for 9% of all hospital's deaths (Tellal *et al.,* 2009). The predominant malaria parasite in Sudan is Plasmodium falciparum, which is responsible for about 90% of human infection. While *P. vivax* is reported in Eastern. Sudan and close to Ethiopian border, *P. malariae* and *P. ovale* are reported in Southern Sudan (Al-Gaddal, 1999; Khalil, 1995). Malaria in Elobeid was once considered as the most important disease of human, being widely distributed and causing damage to human health. Transmission of the disease is confined to rainy season, while the frequency of malaria causes peaks after rainy season. The disease situation in the town remained with little progress. The use of insecticides, impregnated nets and drugs for prevention and treatment over the decade declined in the incidence but still the control programs are inadequate (Elhag,2003). Malaria is transmitted exclusively through Anopheles mosquito bites. The intensity of transmission depends on many factors related to the parasite, the human host, the vector and the environment. Members of the *Anopheles gambiae* complex are the most important vectors of malaria in sub-Saharan Africa. The complex consists of about seven species that vary in their ability to transmit malaria (White 1974; Hunt *et al.,* 1998).

The aim of research is:

1-Explaining the relationship between the malaria vector and water sources in the region

2-Explaining the possibility of vector reproduction through unnatural sources

3- Explaining the places where the malaria vector can breed in homes

2. Material and Methods
2.1. Study Design and Characteristics of Participants

A questionnaire was used to collect relevant demographic and clinical information from patients waiting to be seen by doctors. The questionnaire was designed in a simple local language so that everyone can understand its questions.

2.2. Water Sources

Due to the importance of the water sources in the study area and its relationship with mosquito breeding, people in the study area were asked about the sources of their drinking water, the duration of the water flow in the area, the containers they use to keep water, whether they change water every three days, the presence of stagnant water near their houses and the relationship between the increase in the number of mosquitoes and incidence of malaria.

2.3. Statistical Analysis

Data was collected through standardized questionnaire and checked for errors and completeness. The data were double entered in Microsoft Excel data sheet, cross checked and transferred, and analyzed using SPSS for Windows version 16. Descriptive statistics were carried out to measure relative frequencies, percentages, and correlation and were used to further determine the statistical significance and differences of relative frequencies.

3. Results
3.1. Source of water

Tap water was the main source of water in the town. About (62,9%) of the study population obtained water from tap water while (35.9%) obtained the water from outside like those who transport it by carts from tanks or wells although they had tap water in their houses. Some of the people used purified water but their percentage was only (1.2%) and the majority of them came from outside the town (Table 1).

Table 1: Sources of water

		Frequency	Percent	Valid percent	Cumulative percent
Valid	**Tap water**	107	62.9	62.9	62.9
	From outside	61	35.9	35.9	98.8
	Purified water	2	1.2	1.2	100.0
Total		170	100.0	100.0	

3.2. Continuous supply of water

Of the displaced population 36.5% received water three times a week while 35.9% received the water throughout the week while18.8% received the water twice a week and 8.8% never received any tap water (Table 2).

Table 2: The continuity of water supply

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**All the week**	61	35.9	35.9	35.9
	Twice a week	32	18.8	18.8	54.7
	Three times	62	36.5	36.5	91.2
	Never	15	8.8	8.8	100.0
Total		170	100.0	100.0	

3.3. Containers are used to store water.

The containers used to store water in the town. Zeers constitute the higher percentage for storing water during the flow of tap water in the town (31.8%) while (24.1%) of the surveyed houses used the barrels. (22.9%) user's Zeers, barrels, stand tanks and upper ground tanks. Zeers and barrels (9.4%) users were higher than underground tank (6.5%) and upper ground tank (5.3%).

3.4. Water Storage Habits

Results of response to ways of water storage, changing of water every three days, presence of water near the house and whether storing water increased the number of mosquitoes. The majority of the study population (87.1%) stored water for a week, 9.4% stored water for more than a week, while 3.5% stored water less than a week (Table 4). When asked about whether changing water every three days, the majority of respondents (79.4%) answered with yes while 20.6% said no (Table 4.1).71.8% of the people reported no stagnant water near their houses and 28.2% reported presence of stagnant water near their houses (Table 4.2). When asked about their knowledge about whether storing water will increase the number of mosquitoes or not 94.1% of the respondents said yes while 5.9% said no (Table 4.3).

Table 4: Duration of Water Storage

		Frequency	Percent	Valid percent	Cumulative percent
Valid	**Week**	148	87.1	87.1	87.1
	More than week	16	9.4	9.4	96.5
	Less than week	6	3.5	3.5	100.0
Total		170	100.0	100.0	

Table 4.1: Changing water every three days

		Frequency	Percent	Valid percent	Cumulative percent
Valid	**Yes**	135	79.4	79.4	79.4
	No	35	20.6	20.6	100.0
Total		170	100.0	100.0	

Table 4.2: Presence of stagnant water near the home

		Frequency	Percent	Valid percent	Cumulative percent
Valid	**Yes**	48	28.2	28.2	28.2
	No	122	71.8	71.8	100.0
	Total	170	100.0	100.0	

Table 4.3: Whether storing water increases the number of mosquitoes

		Frequency	Percent	Valid percent	Cumulative percent
Valid	**Yes**	160	94.1	94.1	94.1
	No	10	5.9	5.9	100.0
Total		170	100.0	100.0	

3.5. Knowledge about the Vector of Malaria

Out of 170 interviewed 121 (71.1%) reported that mosquito bite the main factor for cause malaria, (11.1%) unhygienic surrounding, (5.2%) others and (12.3%) mosquito bite plus unhygienic surrounding. As shown in Table (5), using chi- square test, the knowledge about mosquito breeding sites was statistically significant: the recent age of the subjects with adequate knowledge was high in stagnant water (73.5%), under zeers (6.6%), other places (3.5%) and stagnant water plus under zeers (15.7%).

Table 5: Knowledge of Malaria Vector

Characteristics	Total	Mean	Std- Deviation	Test	P-Value
Cause malaria					
Mosquito bite	121(71.1%)				
Unhygienic surrounding	19(11.1%)				
Others	9(5.2%)	1.59	1.04	$2x = 195.27$	> 0.000
Mosquit. Unhy	21(12.3%)				
Mosquito breeding					
Stagnant water	125(73.5%)				
Under zeers	13(6.6%)				
Other places	6(3.5%)	1.61	1.11	$2x = 218.37$	> 0.000
Stag + Unde	21(15.7%)				
Number of mosquito is much in your house					
Yes	81(47.6%)	1.52	0.50	$2x = 0.37$	> 0.000
No	89(52.3%)				

4. Discussion

Most of the respondents (62.0%) obtained water from tap water though the flow of water continues for only two times a week, so people in the town store water in containers. These containers as described before became suitable artificial breeding sites for mosquitoes, most of the respondents storing water for more than a week, tend to change water every three days according to their knowledge about the relation between stagnant water and the breeding sites of mosquitoes. There was negative correlation between the types of building, source of water with causes of malaria (P> 0.05). This result indicates that the members of displaced population were familiar with the disease and have better understanding of malaria causes and symptoms, treatment, and preventive measures. Most of the respondents have a better understanding about the attack of malaria if the symptoms were repeated. In the town during the year 2010, 88.2% of the interviewed patients had malaria, out of them 36.4% with the malaria repeated after a week and 93.5% of the respondents had adequate knowledge that malaria was a dangerous disease with high significance ($x^2=128.84$); also, the respondents had good knowledge that malaria causes death (84.7%). Like elsewhere in Africa, the study community identified malaria mainly based on the symptoms of fever/high temperature and general body weakness, fever with rigors and fever with sweating (Mboera, 2007). The current study revealed that respondents recognize that malaria is a curable disease (90.5%) and the repeated for one month is 48.3% among the respondents, with 24.7% of them had attack twice a month and 27% with attack more than twice. This result indicates that the population is at high risk of malaria disease. In this study, health facilities were the most common sources of malaria treatment in the study population. The observation was similar with studies in Tanzania .

References

Al-Gaddal, A.A., 1999. The experience of the Blue Nile Health project in control of malaria and other water associated disease in Malaria Africa, HO. Genera, 51-58.

Elhag, F.H.A., 2003. Study on mosquitoes of Elobeid north Kordofan- with emphasis on Anopheles arabiensis as malaria vector. M.Sc. thesis, Faculty of Science. University of Kordofan.

Global Health, Division of Parasitic Diseases and Malaria, 2018. Malaria Diagnosis (USA).

Global Health, Division of Parasitic Diseases and Malaria, 2019.

Hunt, R.H., M. Coetzee, and M. Fettene, 1998. The Anopheles gambiae complex: a new species from Ethiopia. Tran. R. Soc. Trop. Med. Hyg., 92: 231-235

Khalil, I.F., 1995. Sensitivity of Chloroquine, Pyrimithamine Sulphadoxine, and Mephloquine and Hallofantrin in Gedarif, Sudan. M.Sc., Khartoum.

Minakawa Nobora, George Sonye,Motoyoshe Mogi, Andrew Githeko, Guiyun Yan. The effects of climatic factors on the distribution and abundance of Malaria vectors in the distribution in Kenya.Jornal of Medical Entomology, Volum39, Issue 6,1 Novomber2002, Pages833-841.

Mboera, 2007. Oifactory medication of oviposition in Anopheles mosquitoes. PhD thesis, Wageningen University, Wageningen, the Netherlands. ISBN: 978-94-6395-363-4

Tellal, B., C. Jonathan, M.H. M'oawia, G.J. Bart, Q.B. Mark, A.M. Colin, B. Ahmed, and B. Badria, 2009. Spatial and temporal distribution of the malaria mosquito *Anopheles arabiensis* in northern Sudan: influence of environmental factors and implications for vector control. Malaria, 10: 1475-2875.

WHO Guidelines for The Treatment of Malaria, 3rd Edition, 2019. www.who. int/malaria/ publications/ atoz/9789241549127/en/

WHO, 2018. World Health Organization Report. WHO, 2017. World Health Organization Report.

White, G.B., 1974. Anopheles gambiae complex and disease transmission in Africa. Trans. R. Soc. Trop. Med. Hyg., 68: 278-301.

Lindsay, S.W., L. Parson, and C.J. Thomas, 1998. Mapping the ranges and relative abundance of the two principal African malaria vectors, Anopheles gambiae sensu stricto and An. arabiensis, using climate data. Proc. R. Soc. Lond. Ser. B. Biol. Sci., 265:847-854.

Steve, L., K. Matthew, B. Enis, and B. Robert, 2004. Environmental management for malaria control in the east asia and pacific (eap)region, Washington, World Bank.

Zimmerman, P.A., R.K. Mehlotra, L.J. Kasehagen, and J.W. Kazura, 2004. Why do we need to know more about mixed Plasmodium species infections in humans? Trends in Parasitology, 20: 440-447.