Prevalence and Associated Risk Factors of Malaria in North-Western Ethiopia

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Summary

BACKGROUND

Malaria is one of the most distributed human parasitic diseases ranking first in terms of its socioeconomic and public health importance in the tropical and subtropical regions of the world. It is prevalent in tropical and subtropical countries and becomes a challenge to a highly endemic area of Africa including Ethiopia. In Ethiopia, due to the variation in geography and ecology, the transmission of malaria is highly variable. This study aimed to provide the current prevalence of malaria, the segment of the population affected and to identify the risk factors that aggravate malaria transmission.

MATERIALS AND METHODS

The study was conducted in Bahir Dar Zuria Woreda West Gojjam zone, North-west Ethiopia which consists of 9 health centres and 36 health posts. A cross-sectional design was conducted from June to August 2020 on 391 study participants visiting three randomly selected Health Centers and ordered to give a blood sample for investigation. Socio-demographic data were collected using a standardized questionnaire. Data were entered and analyzed using SPSS version 26 software. P-value <0.05 was considered statistically significant.

RESULTS

Of a total of 391 participants in the current study 111 (28.4%) were positive for malaria parasites. The presence of stagnant water in their resident area increases the risk of malaria infection by 8.1 times more than respondents having no stagnant water in their resident area (AOR: 8.1, CI: 95%: 3.381-19.18, P = 0.000). Respondents, who do not have a habit of using bed nets had a risk of 66.25 times more likely to be infected by malaria than those who have a habit of using bed nets (AOR: 66.25, CI: 95%: 28.80-152.38, P = 0.000). Malaria prevalence was significantly associated with education (χ^2 =13.960, p < 0.001) and occupation (χ^2 =11.335, p=0.003).

CONCLUSION

The prevalence of malaria was 28.4% (111). Males were a more affected group than females and *Plasmodium vivax* was the most prevalent species with 76.58% (85). Educational status, presence of stagnant water and habit of using bed nets were the risk factors associated with the prevalence of malaria.

***Keywords**: Malaria, Bahir Dar Zuria Woreda, P. vivax, P. falciparum, Risk factor*

[*Afr. J.* *Health Sci*. 2022 35(4): 446-454]

Introduction

Malaria is a leading cause of morbidity and mortality in many countries throughout the world. It is caused by protozoan parasites of the genus *Plasmodium*. It is transmitted from one person to another by the bite of an infected female Anopheles mosquito [1, 2, 3]. Globally, there were an estimated 229 million malaria cases and 409 000 deaths in 2019 in 87 malaria-endemic countries. Out of which, 94 % of the cases and most of the deaths were accounted for by African Region. The percentage of total malaria deaths among children aged under 5 years was 67% in 2019 [4].

In Ethiopia, malaria is a major public health problem, which is persistently reported as a major cause of morbidity and mortality in all age groups. It is approximately distributed in 68% of the Ethiopian population and covers almost 75% of the country's landmass. It is seasonal in most parts of the country, with an unstable transmission that lends itself to the outbreak of epidemics. Malaria occurs in almost all Zones with over 60% of the population being at risk, and it ranks top among the causes of morbidity and mortality in the Amhara Region [5, 6, 7].

Five different types of *Plasmodium* parasites infect humans: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium ovale* and *Plasmodium knowlesi*. Of these, *Plasmodium falciparum* and *Plasmodium vivax* are the most prevalent species. *Plasmodium falciparum* is the most dangerous species and is responsible for most of the deaths worldwide caused by malaria [8, 9].

As far as Ethiopia is concerned, four species including *Plasmodium falciparum*, *Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae* are known to infect human beings. Like other parts of the world, *Plasmodium falciparum* and *Plasmodium vivax* are by far the most predominant and widely distributed parasites in Ethiopia [10-14].

As different studies revealed that poor environmental sanitation and housing conditions, as well as lack of appropriate control measures, might be significant risk factors for malaria parasite burden needs [15-18]. The study will provide the current prevalence of malaria, the segment of the population affected and identify the risk factors that aggravate malaria transmission in the study area.

Methods and Materials

Study area

The study was conducted in Bahir Dar Zuria Woreda West Gojjam zone, North-west Ethiopia. The Woreda consists of 9 health centres and 36 health posts. The altitude of Bahir Dar Zuria Woreda is 1500-2500m above sea level. The annual rainfall is 820-1250 ml. The minimum annual temperature ranges from 10°_{C} - $32^{\circ}_{C.}$ The daytime temperature is very high from February - May. But the months between October to January are the coldest. Malaria's major transmission period is September to December. This area has extensive irrigation for vegetable and fruit production.

Study design

A cross-sectional study design was conducted from June to August 2020 on patients with complaints of symptoms of malaria. Simple random sampling was applied to select the three Health Centers (i.e. Andasa, Yinesa and Kinbaba) from the nine Health Centers in Bahir Dar Zuria Woreda.

Sample size determination

The sample size was determined using a statistical formula N= $\frac{(z^2 \mathrm{p}(1-\mathrm{p}))}{d^2}$ considering 95% confidence interval and 32.6 % [19] prevalence and also considering 15% none respondent rate. Where, N = sample size, z = 1.96, which is z-statistic for a level of confidence, d = 0.05, which is absolute

precision, and p = expected prevalence of the area. Thus, the total sample was 391 visits at three randomly selected Health Centers.

Sociodemographic data were collected using a standardized questionnaire. For *Plasmodium* parasite detection and identification, a blood film examination was performed based on the standard protocol of the Ethiopian Federal Ministry of Health.

Data quality control

To ensure a reliable result, the quality of Giemsa stain was checked using known negative and positive blood smears. Slides were checked by experienced laboratory technicians. To maintain the quality of generating data, they were checked for completeness and cleanness before starting the analysis.

Inclusion criteria

Patients who complained of symptoms of malaria and were asked to give a blood sample in randomly selected health centres for laboratory investigation and could give consent for the study at the time of the study were included in this study.

Exclusion criteria

Patients who could not give consent at the time of the data collection study were excluded from the study.

Data analysis and interpretation

Data were entered and analyzed using SPSS version 26 software. Descriptive statistics, chi-square tests, logistic regression and odd ratio (OR) were used to show a significant difference between variables. P-value <0.05 was considered statistically significant.

Ethical considerations

Ethical approval was obtained from the Research and Ethical Review Committee of the School of Medicine, College of Medicine and Health Sciences, Bahir Dar University. Based on the approval, permission was obtained from the Woreda Health Office. The risks and benefits of participation in this study were explained to every study participant and informed consent is also obtained from them. Finally, the blood tests were carried out free of charge. All data and information were maintained confidentially by using a code rather than the participants' names.

Results

Demographic data of the study participants

A total number of 391 respondents participated in the study. Out of this, 223(57%) were males and 168(43%) were females. Of the total participants, about 79.3% of participants were farmers and 65% were illiterate and had not received formal education. (Table 1).

Prevalence of malaria based on socio-demographic factor

The overall prevalence of malaria was 111(28.4%). The prevalence of malaria was higher in males (34.5%) as compared to females (20.2%) and variation was statistically significant (χ^2 = 9.626; P< 0.05). Malaria was higher (34.6%) among illiterate and it was statistically significant (χ^2 = 13.960; P< 0.05). When reviewing any association between occupation and malaria, farmers made up the highest number (100 /32.26%) and the association was statistically significant (χ^2 = 11.335; P< 0.05). (Table 2).

Risk factors associated with the prevalence of malaria

From the results of bivariate analysis of binary logistic regression, demographic and behavioural determinant variables like sex, educational status, presence of stagnant water and habit of using bed nets showed statistically significant association (P< 0.05) with the prevalence of malaria. After adjustment, sex was found insignificantly associated with the prevalence of malaria in multivariate analysis (P> 0.05). Whereas the other variables remained

significantly associated with the prevalence of malaria (Table 3).

Plasmodium species identification

From the total of 111 malaria-infected individuals, infections with *Plasmodium vivax* and *Plasmodium falciparum* occurred with a prevalence of 85(76.58%) and 22(19.82%), respectively, while mixed species was 4 (3.6%) (Figure 1).

Discussion

Despite the considerable progress made since 2000, morbidity and mortality caused by malaria have not reduced significantly yet [2]. It is a major health problem, especially in developing nations including Ethiopia. According to this study, the prevalence of malaria was 28.4%.

***Table 1*:**
Demographic Data of Study Participants

	Variable	**Characteristics**	**Frequency**
Sex	Male	223	57.0
	Female	168	43.0
Age category (year)	<5	103	26.3
	5-14	78	19.9
	15+	210	53.7
Religion	Orthodox	371	94.9
	Muslim	12	3.1
	Protestant	8	2.0
Educational status	Illiterate	254	65.0
	Literate	137	35.0
Occupation	Civil servant	22	5.6
	Merchant	59	15.1
	Farmer	310	79.3

Table 2:
The Prevalence of Malaria based on Socio-Demographic Factor.

	Respondents	n (%)	χ^2	*P*-value
Sex				
Male	223	77 (34.5%)	9.626	0.002
Female	168	34 (20.2%)		
Age				
<5	103	25 (24.27%)	3.588	0.166
5-14	78	18 (23.08%)		
15+	210	68 (32.4%)		
Educational Status				
Illiterate	254	88 (34.6%)	13.960	0.000
Literate	137	23 (16.9%)		
Occupation				
Civil servant	22	4 (18.20%)	11.335	0.003
Merchant	59	7 (11.90%)		
Farmer	310	100 (32.26%)		

This study is in line with studies conducted in Jimma town South Western Ethiopia (29.8%) [20], Tselemti Wereda, North Ethiopia (28.1%) [21], Woreta town, North West Ethiopia (32.6%) [19] and Kola Diba, North West Ethiopia (39.6%) [10]. However, the prevalence of malaria was lower in studies conducted in Arsi Negelle, South Western Ethiopia (11.45%) [22], Kombolcha, Central Ethiopia (7.52%) [23], Butajira area, South-central Ethiopia (0.93%) [24] and Suhul General Hospital, northwestern Tigrai (6.96%) [25]. Concerning sex, malaria prevalence was higher in males (34.5%) as compared to females (20.2%). Our findings in agreement with findings from studies done in Arsi Negelle, South Western Ethiopia (Male=55%, Female=45%) [22], Kola Diba, North West Ethiopia (male=52.6%, female=47.3%) [10], Kombolcha, Central Ethiopia (Male=68.1%, female=30.98) [23].

Table 3:
Binary Logistic Regression Analysis for Factors Associated with Malaria among Respondents.

Risk factors	Positive (%)	Negative (%)	Adjusted OR (95% CI)	P-value
Sex				
Male	77(34.5)	146(65.5)	1.21 (0.573-2.550)	0.619
Female	34(20.2)	134(79.8)		
Educational Status				
Illiterate	88(34.6)	166(65.4)	2.66(1.185-5.977)	0.018
Literate	23(19.6)	114(80.4)		
Stagnant water				
No	26(14.5)	153(85.5)		
Yes	85(40.1)	127(59.9)	8.1 (3.381-19.18)	0.000
The habit of using beds net				
Yes	22(7.7)	263(92.3)		
No	89(84)	17(16)	66.25 (28.80-152.38)	0.000

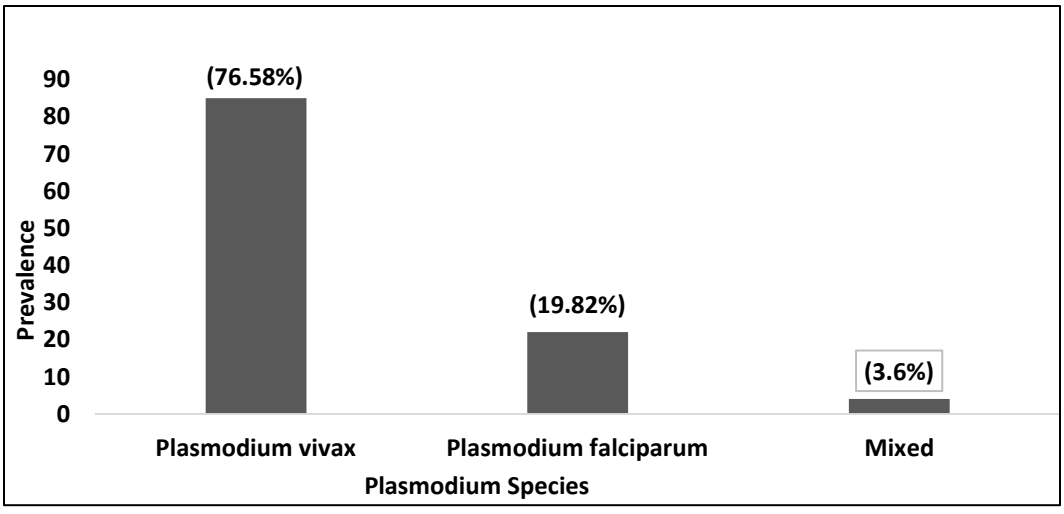

Figure 1:
Prevalence of Plasmodium Species

Also from Metema Hospital, Northwest Ethiopia (Male=18%, female=15.8%) [26], Woreta town, North West Ethiopia (male=52.9%, female=47.1%) [19], Tselemti Wereda, North Ethiopia (male=29.5, female=26.5) [21], and Suhul General Hospital, northwestern Tigrai (male=68.4%, female=31.6%) [25]. This difference may be attributed to males being mostly engaged in outdoor activities. But, in a study done at Assosa Zone, Western Ethiopia, the prevalence of malaria was higher (Male=45.8%, female=54.2%) [27] in females.

A higher (32.4%) prevalence of malaria was detected in the 15 and above age categories than in the remaining age categories less than 5 (24.27%) and 5-14 (20.08%). This may be due to adults being mostly engaged in outdoor activities. But, There was no statistically significant association ($\chi 2 = 3.588$; $P>0.05$) on the prevalence of malaria among age categories (Table 2). This study is supported by other studies conducted at Kola Diba, North West Ethiopia [10], Kombolcha, Central Ethiopia [22], Tselemti Wereda, North Ethiopia [21] and Suhul General Hospital, northwestern Tigrai [25]. However, the prevalence of malaria was higher in under-five children in a study done in Arsi Negelle, South Western Ethiopia [22]. On the other fashion, the prevalence of malaria was higher in the age group 5-14 in studies conducted at Metema Hospital, Northwest Ethiopia [26] and Woreta town, North West Ethiopia [19].

Based on educational status, the prevalence of malaria was higher (32.10%) among illiterate individuals compared to literate with a value of 88 (34.6%) and 23 (16.9%), respectively. The prevalence of malaria among educational status categories of respondents was statistically significant ($\chi^2 = 13.960$; $P< 0.05$) (Table 2). Illiterates were 2.66 times more likely to be infected by malaria than literates (AOR: 2.66, CI: 95%: 1.85-5.977). This result is in line with a study done in West Armachiho District, Northwest Ethiopia [28].

Concerning occupation, a higher prevalence (32.26%) of malaria was detected among respondents in farmers compared to merchants and civil servants with a value of (11.90%) and (18.20%), respectively. The association among respondents' occupations was statistically significant ($\chi^2 = 11.335$; $P< 0.05$). (Table 2). This difference may be attributed to males being mostly engaged in outdoor activities like agricultural and irrigation activities, which in turn increase the chance of infection. In addition to this, most of the farmers in the study area were illiterate and may not act according to the guidelines of the malaria prevention strategy. Thus, they can be prone to infection.

From the results of multivariate analysis of binary logistic regression on educational status, the presence of stagnant water and the habit of using bed nets showed a statistically significant association ($P< 0.05$) with the prevalence of malaria.

The presence of stagnant water in the respondent's resident area increased the risk of malaria infection by 8.1 times more than respondents having no stagnant water in their resident area (AOR: 8.1, CI: 95%: 3.381-0.079). This result is supported by studies done in Jimma town, southwest Ethiopia [20] and Huang-Huai plain, China [29].

The study population who did not have a habit of using bed nets had an increased risk of malaria infection by 66.25 times more than those who used bed nets (AOR: 66.25, CI: 95%: 28.80-152.38). This is agreed with a study conducted in the Amhara, Oromia and SNNP regions of Ethiopia [30].

Regarding P*lasmodium* species, only two species (*Plasmodium vivax* and *Plasmodium falciparum*) are identified. Of 111 malaria-infected individuals, infections with *Plasmodium*

vivax were about four times more common than *Plasmodium falciparum* occurred with a prevalence of 85(76.58%) and 22(19.82%), respectively, while mixed species was 4 (3.6%). The prevalence of *Plasmodium vivax* was also common in studies done at Arsi Negelle, South Western Ethiopia (74%) [22], Butajira area, South-central Ethiopia (86.5%) [24], and Jimma town, South Western Ethiopia (76.4%) [20]. However, the prevalence of *Plasmodium falciparum* was higher in studies conducted at Kombolcha, Central Ethiopia (60.2%) [23], Tselemti Wereda, North Ethiopia (58.2%) [21], Metema Hospital, Northwest Ethiopia (90.7%) [26], Kola Diba, North West Ethiopia (75%) [10], and Woreta town, North West Ethiopia (69.7%) [19], Suhul General Hospital, northwestern Tigrai (50.2%) [25], and West Armachiho District, Northwest Ethiopia (70.4%) [28]. In all these studies including the current study, the detection of *Plasmodium vivax* and *Plasmodium falciparum* coinfection was less than 6%.

Study limitations

The limitation of this study is that malaria cases were collected only from government-health centres in the study areas. Malaria cases could have been underestimated because patients may seek treatments in other small private clinics that were not included here. It was also limited in assessing the influence of other factors such as nutritional status, and types of house roofs and walls which may have contributed to the occurrence of the disease.

Conclusion

Malaria is still among the major public health problems in Ethiopia. *Plasmodium falciparum* and *Plasmodium vivax* are the most common and widely spread parasites. Of the participants of this study, the overall prevalence of malaria was 111(28.4%). The prevalence was strongly associated with illiteracy, presence of stagnant water and lack of awareness of the habit of using bed nets. Thus, solutions must focus on human behaviour. Generally, the study revealed that malaria is the major health threat in the study area. Hence, prevention and control activities should be continued in a reinforced manner in the study area considering both *Plasmodium vivax* and *Plasmodium falciparum* with due attention to *Plasmodium vivax*.

Competing Interest

The authors declare no conflict of interest in this study.

Source of funding

No financial support was gained to conduct the study

Author contributions

Both authors made considerable contributions to problem identification; design; analysis and interpretation of data; drafting the article or revising critically for important intellectual content and giving final approval of the version to be published. Both authors are accountable for all aspects of the work.

Acknowledgements

We would like to thank the data collectors, the Bahir Dar Zuria Woreda Health office and the study participants involved in this study.

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