Original Article

Prevalence of, and risk factors for, malaria infection among patients visiting Goljota Health Center, Heben Arsi District, West Arsi Zone, Oromia Regional State, Ethiopia: A retrospective and an institution-based cross-sectional study

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Abstract

Background: Malaria infections in Ethiopia are a significant health problem that varies across regions. Malaria's public health and socio-economic impact is huge and contributes significantly to the country's poverty and underdevelopment. The aim of this study was to determine the five-year trend of malaria (2012-2016), and to assess the prevalence and associated risk factors of malaria infection among patients visiting Goljota Health Center from September to December 2017.

Methods: The present study is a retrospective and an institution-based cross-sectional study on the prevalence of malaria. For the cross-sectional study, blood samples collected from 422 patients were processed using thin and thick blood film methods. Also, five years of retrospective data were collected to determine the trend of malaria prevalence. Socio-demographic factors were assessed and logistic regression analyses were employed to determine the independent risk factors for malaria infection.

Results: The prevalence of malaria was 14.8% in 2012, 21.4% in 2013, 14.2% in 2014, 12.9% in 2015 and 13.2% in 2016. The majority of malaria positives were male, with *Plasmodium vivax* accounting for most infections. The highest number of infections were in the ≤10-year-old age group. The overall prevalence of malaria infection in the cross-sectional study was 13% in Heben Arsi *Woreda* (District). Being male (AOR 1.5, 95% CI: 1.06-2.2, p<0.02), using bed nets when sleeping (AOR 0.36, 95% CI: 0.22-0.60, p<0.01), implementing indoor residual spraying in the past five months (AOR 0.06, 95% CI: 0.03-0.10, p<0.01), home not close to breeding site (AOR 0.54, 95% CI: 0.29-0.98, p<0.04), and the absence of an opening/hole in an external house wall (AOR 0.49, 95% CI: 0.27-0.92, p=0.026) showed a negative significant association with malaria infection. So, these factors are protective in relation to malaria infection. Using thatched roof material (AOR 1.64, 95% CI: 1.0-2.7, p<0.02) and having an income of <500 Ethiopian birr per month (AOR 3.1, 95% CI: 1.24-7.9, p=0.02) had a positive significant association with malaria infection.

Conclusions: A strong relationship exists between malaria infection and socio-demographic risk factors. There was a decreasing malaria trend from 2013 to 2015, followed by a small increase in 2016. To further decrease the prevalence rate, intervention strategies should be designed and implemented to address current and local malaria-associated health problems that could help to reduce the problem of malaria among the population in the study area. [*Ethiop. J. Health Dev.* 2021; 35(1):50-57]

Key words: Malaria, health, risk factors, prevalence, south central Ethiopia

Introduction

Malaria is a major human health threat in tropical and subtropical regions of the world. It kills about 1 million people each year (1). About 90% of all malaria deaths in the world occur in Africa, south of the Sahara (2). Severe anemia and cerebral malaria constitute the major causes of death, mostly in children under the age of 5 years (3).

In Africa, over a quarter of school-aged children are at high risk of coincidence infection, and consequently at enhanced risk of clinical diseases (4). According to Eggena *et al.* (5), there are three principal ways in which malaria can contribute to death in young children. First, an overwhelming acute infection, which frequently presents as seizures or coma (cerebral malaria), may kill a child directly and quickly. Second, repeated *Plasmodium* infections contribute to the development of severe anemia, which substantially increases the risk of death. Third, low birth weight, frequently the consequence of *Plasmodium* infection in pregnant women, is the major risk factor for death in the first month of life.

While there are differing intensities of transmission across the regions of Ethiopia, malaria is endemic across the country, except in the central highlands, which are malaria-free. In 2002/03, the disease was reported as the leading cause of morbidity and mortality in Ethiopia, accounting for 15.5% of outpatient consultations, 20.4% of admissions and 27% of in-patient deaths (6). Furthermore, in 2004/05, it was reported to be the leading infectious disease, followed by helminthiasis and tuberculosis (7). Malaria distribution under normal conditions depends largely on topographic and climatic features, and is endemic in warm and moist lowlands. The epidemiological pattern of malaria transmission in Ethiopia is generally unstable and seasonal, with the level of transmission varying from place to place because of altitude and rainfall patterns. The major transmission of malaria follows the June to September rains and the peak transmission occurs during the months of September to December (8), while the minor transmission season occurs between April to May, following the February to March rains (9).

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Climatological changes, such as increased temperatures, humidity, and unusually prolonged heavy rainfall, are considered to aggravate malaria. So-called 'man-made malaria' – which refers to the creation of breeding places of malaria vectors as a result of human activities – contributes considerably to the spread of malaria (10).

Malaria is ranked as the leading communicable disease in Ethiopia, with three-quarters of the total land mass regarded as malarious (11), and two-thirds of the country's population at risk (12). All four species of *Plasmodium* are known to occur in Ethiopia (13). Malaria appears to be on the decline in Ethiopia which have greatly increased coverage of insecticide-treated bed nets (ITNs) and indoor residual spraying (IRS), and expanded programs for the diagnostic testing and treatment of malaria (14). The main malaria control strategies in Ethiopia include: early diagnosis and prompt treatment, selective vector control, epidemic management and control, environmental management, and personal protection through the use of ITNs (6).

This study aims to examine the prevalence of, and risk factors for, malaria infection among patients in Heben Arsi District, a rural area in south central Ethiopia. We present data on the prevalence of, and risk factors for, malaria infection, and retrospective data among patients in Heben Arsi District using an institution-based cross-sectional study. After defining the prevalence of, and risk factors for, malaria infection, we briefly outline possible interventions.

Materials and methods

Study area and study population: A retrospective study (2012-2016) and an institution-based cross-sectional study (September to December 2017) were conducted to assess the magnitude of malaria and risk factors among patients in Heben Arsi District, West Arsi Zone, Oromia Regional State. Heben Arsi District is 226 kilometers from Addis Ababa, the capital city of Ethiopia. A total of 422 patients participated in the cross-sectional study. The study participants were patients visiting Goljota Health Center in Heben Arsi District. According to the district information and communication office, the total population in the district is about 78,068, of whom 38,893 are males and 39,175 are females.

Sample size determination: For the cross-sectional study, sample size was estimated using Daniel's formula (15), where P = 50%, since there was no previous reported malaria prevalence study in the area; d = margin of error; Z = standard score, corresponding to 1.96, with a 95% confidence interval, and 5% margin of error. This would give a sample size of 384. To compensate for non-response and incompleteness, an additional 10% was added, giving a total of 422 study participants.

$N=Z^2 P (1-P)/d^2$

Where:

N = total number of subjects required in the population

Z = a standardized normal deviate value that corresponds to a level of statistical significance equal to 1.96

P = estimate of prevalence of malaria is 50%

d = margin of error, which corresponds to the level of precision of results desired

$$N = \frac{(1.96)^2\ 0.5(1-0.5)}{(0.05)^2} = 384.16$$

Non-response rate = 10% of N = 10/100 (384) = 422

Total sample size = 384 + 38.4 = 422

Data collection: Five years (2012-2016) of retrospective data were collected from health center registration books. A format was prepared on a computer spreadsheet (Excel) to collect secondary data from Goljota Health Center log books. Individual-level data on malaria morbidity, such as diagnosis results (positive and negative), dates of diagnoses, and available demographic data (residence, age, sex) were recorded on the computer spreadsheet. All records of patients who visited the health institution during the timeframe who were considered and treated as malaria patients were included in the study. Records of cases with incomplete records, such as no dates of health service visits, age, address, and results of diagnoses, were excluded from the analysis. Furthermore, for the cross-sectional study, a structured and pre-tested questionnaire was used to collect information on participants' socio-demographic/economic status. Finger prick blood collection was done by health professional workers, and thick and thin blood smears were prepared on the same slides. During the data collection, constant monitoring and supervision were carried out. All the activities of the interviewers, the nurses and laboratory technicians were supervised.

Data analysis: The data were initially checked for completeness and consistency, coded and entered into the computer, and validation was performed in Microsoft Excel 2010 spreadsheets. The data were then exported to SPSS version 20 for analysis. Chi-squared tests were carried out to verify possible associations between malaria infection and exposure to different factors. Univariate analysis was used to identify the possible confounders. Variables that were associated with both exposure and outcome variables in the crude analysis using statistical significance at p-value <0.2 were considered to be possible confounders. Multivariate logistic regression analysis was used to measure the strength of association of socio-demographic factors and malaria infections. A 95% confidence interval (CI) was calculated for the odds ratio value. Values were considered significant when $p<0.05$.

Ethical considerations

The study was reviewed and approved, and ethical clearance was obtained from, the Ethical Committee, College of Natural Sciences, Hawassa University. West Arsi Zone Education and Health Departments passed the message of permission to Goljota health centre at Heben Arsi district. Participation in the study was on a voluntary basis. Privacy and confidentiality of the information was ensured. The ethical considerations were addressed by treating positive patients using standard drugs under the supervision of a local nurse.

The objective of the study was explained to participants; written consent was obtained from all participants, including children who gave their assent before samples were collected.

Results

Socio-demographic characteristics: The socio-demographic characteristics of respondents are summarized and presented in Table 1. A total of 422 respondents were included in the study, of whom 226 (53.6%) were males and 196 (46.4%) were females. Ninety-six (22.7%) samples were from children aged less than 5 years, 176 (41.7%) from those between the ages of 6 and 18 years; 99 (23.5%) from those between the ages of 19 and 40 years; and 51 (12.1%) from those older than 40. The vast majority of the respondents were rural residents. One hundred and forty-six (34.6%) of the study participants were illiterate, while 125 (29.6%) could read and write; 110 (26.1%) had primary education, 30 (7.1%) had secondary education, and 11 (2.6%) had higher education.

As indicated in Table 1, in terms of the respondents' heads of household, 216 (51.2%) were farmers, 170 (40.3%) were self-employed, 13 (3.1%) were public servants and 23 (5.5%) were private sector employees. The monthly income of the majority of the respondents' heads of households – 220 (52.1%) – was 500 to 1,000 Ethiopian Birr (ETB); 119 (28.2%) had a monthly income of less than 500 ETB; and 83 (19.7%) had an income of more than 1,000 ETB. One hundred and seventy-one (40.5%) households had family sizes of less than five, and 251 (59.5%) had family sizes greater than five.

Table 1: **Socio-demographic/economic characteristics of respondents**

Characteristics		**No. (%)**
Sex	Male	226 (53.6)
	Female	196 (46.4)
Age	<5	96 (22.7)
	6-18	176 (41.7)
	19-40	99 (23.5)
	>40	51 (12.1)
Residence	Urban	108 (25.6)
	Rural	314 (74.4)
Educational status	Illiterate	146 (34.6)
	Only read and write	125 (29.6)
	Primary education	110 (26.1)
Occupation	Public servant	13 (3.1)
	Private sector	23 (5.5)
	Self employed	170 (40.3)
	Farmer	216 (51.2)
Income (ETB)	Above 1,000	119 (28.2)
	500-1,000	220 (52.1)
	<500	83 (19.7)
Family size	<5	171 (40.5)
	>5	251 (59.5)

Trends of malaria prevalence among patients: In this study, data were obtained from malaria records held at Heben Arsi District, (see Table 2). Based on a health center record analysis of malaria over five years (2012-2016), a total of 8,341 blood films were diagnosed. Of these 1,286 (15.41%) were positive for malaria. Regarding identified *Plasmodium* species, *P. vivax* accounted for 660 (51.32%) cases, *P. falciparum* accounted for 511 (39.73%) cases, and mixed infection was reported in 117 (8.94%) cases over the five years. Malaria cases in the study area showed a fluctuating trend. The prevalence of malaria was 14.8% in 2012, 21.4% in 2013, 14.2% in 2014, 12.9% in 2015, and 13.2% in 2016. The highest annual cumulative prevalence of malaria was detected in 2013; this was much higher than in all other years.

Table 2: **Malaria prevalence among patients in** Heben Arsi District, West Arsi Zone**, 2012-2016**

***Plasmodium* species**	**Years**				
	2012 No. (%)	2013 No. (%)	2014 No. (%)	2015 No. (%)	2016 No. (%)
P. vivax	152 (8)	207 (11.64)	87 (7)	81 (5.9)	133 (6.4)
P. falciparum	97 (5.2)	165 (9.3)	78 (6.3)	64 (4.7)	107 (5.1)
Mixed	27 (1.5)	9 (0.5)	11 (0.9)	32 (2.3)	36 (1.7)
Total	276 (14.8)	381 (21.4)	176 (14.3)	177 (12.9)	276 (13.2)

Malaria distribution among different sex groups: As shown in Table 3, the majority of malaria positives were male and *P. vivax* accounted for most infections, followed by *P. falciparum*.

Table 3: **Prevalence of malaria infection by sex in Heben Arsi District, 2012-2016**

Year	Sex	*Plasmodium* species		
		P. vivax No. (%)	*P. falciparum* No. (%)	Mixed No. (%)
2012	Male	84 (55.3)	54 (55.8)	15 (55.6)
	Female	68 (44.7)	43 (44.2)	12 (44.4)
2013	Male	117 (56.5)	85 (51.5)	5 (55.6)
	Female	90 (43.5)	80 (48.5)	4 (44.4)
2014	Male	47 (54)	42 (53.8)	7 (63.6)
	Female	40 (46)	36 (46.2)	4 (36.4)
2015	Male	45 (55.6)	34 (53)	16 (50)
	Female	36 (44.4)	30 (47)	16 (50)
2016	Male	68 (51)	57 (53.3)	19 (52.8)
	Female	65 (49)	50 (46.7)	17 (47.2)

Malaria distribution among different age groups: As shown in Table 4, over all five years, of the 1,286 malaria positive individuals, the highest number of infections was seen in the ≤10-year-old age group, followed by those aged between 11 and 20. The highest prevalent malaria species was *P. vivax*.

Table 4: **Prevalence of malaria infection among different age groups in** Heben Arsi District**, 2012-2016**

Year	Age	*Plasmodium* species		
		P. vivax No. (%)	*P. falciparum* No (%)	Mixed No. (%)
2012	≤ 10	42 (27.5)	30 (31)	8 (30.5)
	11-20	35 (23.3)	20 (21)	6 (21.7)
	21-30	19 (12.5)	14 (14)	4 (14.5)
	31-40	19 (12.4)	13 (13)	4 (15)
	≥ 41	37 (24.3)	20 (21)	5 (18.3)
2013	≤ 10	51 (24.5)	44 (26.5)	3 (29.3)
	11-20	42 (20.3)	36 (21.7)	2 (23.4)
	21-30	32 (15.5)	19 (11.7)	1 (12.7)
	31-40	40 (19.4)	27 (16.5)	1 (14)
	≥ 41	42 (20.3)	39 (23.6)	2 (20.6)
2014	≤ 10	26 (29.6)	21 (26.6)	4 (31.6)
	11-20	18 (20.1)	17 (21.6)	3 (24.2)
	21-30	13 (14.8)	10 (12.9)	1 (12.5)
	31-40	11 (12.6)	14 (17.4)	2 (14.9)
	≥ 41	20 (22.9)	17 (21.5)	2 (16.8)
2015	≤ 10	26 (31.6)	22 (33.5)	11 (33.6)
	11-20	25 (30.6)	17 (26.5)	9 (28.8)
	21-30	10 (12.8)	11 (16.7)	6 (17.5)
	31-40	9 (11.4)	6 (9.7)	5 (14.9)
	≥ 41	11 (13.6)	8 (13)	2 (5.2)
2016	≤ 10	39 (29.4)	29 (27)	9 (23.5)
	11-20	29 (21.7)	25 (23.5)	7 (20.8)
	21-30	14 (10.8)	15 (14)	7 (19.2)
	31-40	23 (16.9)	17 (15.9)	6 (17.3)
	≥ 41	28 (21.2)	21 (19.6)	7 (19.2)

The prevalence of malaria parasites: Microscopic blood sample examination using thin and thick blood films in the institution-based cross-sectional survey showed the extent of malaria parasite infections found in Heben Arsi District (see Figure 1). A total of 422 patients were sampled, of whom 226 (53.6%) were males and 196 (46.4%) were females. Of the 422 patients examined, two species of malaria parasites were identified, with an overall prevalence of 55 (13%). Of the 13% prevalence, 60% were positive for *P. vivax* and 23.6% for *P. falciparum*; the remainder (16.4%) showed mixed infection. Ninety-six (22.7%) of the study subjects were under 5 years old; 176 (41.7%) were between the ages of 6 and 18; 99 (23.5%) were between the ages of 19 and 40; and 51 (12.1%) were older than 40. The majority of the respondents were rural residents.

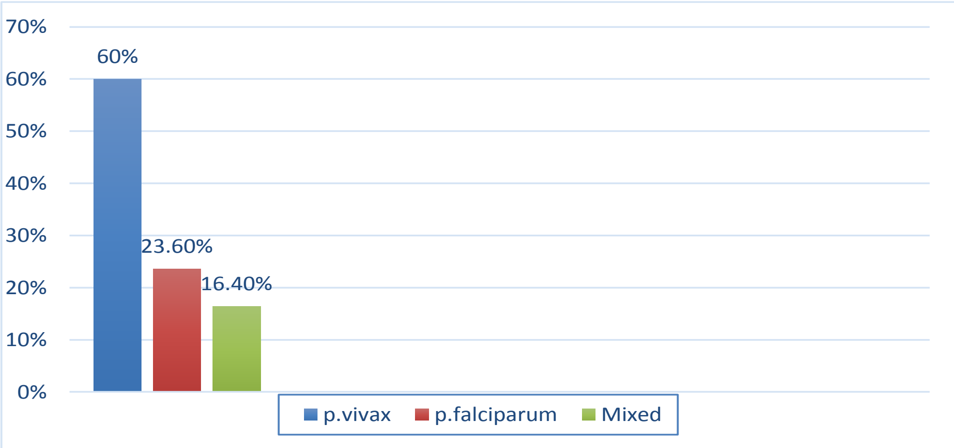

Figure 1: **Distribution and types of *Plasmodium* species in Heben Arsi District, September to December 2017**

Results of this study showed that 55 (13%) had malaria parasites. Malaria infection in males was 1.5 times higher than in females (see Table 5). Study subjects who used bed nets were less likely to be infected with malaria parasites. The use of bed nets was found to be protective against malaria infection, reducing the likelihood of infection by 64%. Indoor residual spraying (IRS) in the past five months was also protective against malaria infection, reducing the likelihood of infection by 94%. Moreover, study subjects whose homes were not close to the breeding sites of vectors were less likely to be infected with malaria. In other words, living in a home far away from breeding sites was found to be protective against malaria, reducing the likelihood of infection by 46%. Study participants who had no hole/opening on an external wall of their home were less likely to be infected with malaria parasites by 51%. Study participants who had a monthly income of <500 ETB were 3.1 times more likely to be infected with malaria parasites compared those who had a monthly income of >500 ETB (see Table 5).

Table 5: Univariate and multivariate analysis of some risk factors for malaria prevalence among patients in Heben Arsi District south central Ethiopia, 2015-2016

Variable		Malaria* positive (%)	COR (95% CI)	p-value	AOR (95% CI)	p-value
Gender	Male	100 (44.2)	1.53 (1.03-2.27)	0.02	1.5 (1.06-2.2)	0.02
	Female	67 (34.2)	1		1	
Residence	Urban	41 (38.7)	1		1	
	Rural	126 (40)	0.95 (0.68-1.3)	0.74	1.02 (0.64-1.9)	0.71
Use of bed nets	Yes	121 (35.0)	1		1	
	No	46 (59.4)	0.37 (0.25-0.55)	<0.001	0.36 (0.22-0.60)	<0.001
IRS in the past five months	Yes	34 (10.8)	0.06 (0.04-0.08)	<0.001	0.06 (0.03-0.10)	<0.001
	No	75 (67.3)	1		1	
Home closer to breeding site	No	26 (19.4)	2.2 (1.21-3.82)	0.009	0.54 (0.29-0.98)	0.04
	Yes	29 (10.1)	1		1	
Roof material	Iron sheet	38(48.7)	1		1	
	Thatch	127 (36.6)	1.6 (1.4-2.0)	0.01	1.64 (1.0-2.7)	0.02
Opening/hole in wall	Present	36 (16.4)	1		1	
	Absent	19 (9.4)	0.53 (0.29-0.95)	0.036	0.49 (27-0.92)	0.026
Income (ETB)	<500	23 (19.3)	2.0 (1.06-6.39)	0.037	3.1 (1.24-7.9)	0.018
	501-1,000	25 (11.4)	1.4 (0.58-3.35)	0.46	1.8 (0.73-4.48)	0.203
	>1,000	7 (8.4)	1		1	

AOR: adjusted odds ratio; CI: confidence interval; COR: crude odds ratio.
*The percentage is calculated from the total examined for the respective characteristic.

Discussion

Compared to previous reports on malaria infection in different parts of Ethiopia, the prevalence of malaria infection in the present study populations was higher in some cases, and lower in others. This could be explained by differences in the risk factors in different localities, such as environmental sanitation, health facilities, differences in altitudes that favor mosquito breeding, and differences in vector control by communities. The highest proportion of annual malaria cases (21.4%) was in 2013 and the lowest (12.9%) in 2015. The findings of the present study are higher than those of studies conducted in the Butajira area of southern Ethiopia, at just 0.93% (16), and in Gurage (17), at 2.8%. Furthermore, malaria prevalence in the past five years showed a declining trend. This might be due to improvements in vector control, better accessibility to health facilities, and increased community awareness.

It was also observed that the overall malaria prevalence was lower compared to Hallaba, Dilla, and Sibu Sire District in East Wollega Zone Oromia Region; East Shewa Zone in Oromia Region; and Berahel Health Center in Afar Region (18-21), with prevalence rates of 82.4%, 16%, 20.07%, 82.8% and 19.4%, respectively. The observed differences might be due to altitude variations, the study period, differences in health accessibility, community awareness of vector control, as well as ITN and IRS coverage.

In the current institution-based cross-sectional survey, the overall prevalence of malaria among suspected patients in the period between September and December 2017 was 13.03%, which was slightly lower than the previous year. This might be due to better ITN and IRS coverage in the study area. This result is similar to the findings of studies conducted in Oromia Region, at Awash Melkasa Health Center and Melka Belo *Woreda* (22-23). This might be due to similar climatological changes, such as temperature and humidity. Additionally, the prevalence rate in the current study was higher than in studies conducted in Arba Minch Hospital and Arsi Negelle Health Center (24-25), which were 7% and 11.45%, respectively. This could be due to differences in climatological changes, such as increased temperature and humidity, and ITN and IRS coverage.

In the current retrospective study, *P. vivax* was the dominant or highly prevalent species within the study area. This contradicts the findings reported in a study conducted in Felegehiwot Referral Hospital in Bahir Dar, north west Ethiopia, where the highest prevalent malaria parasite was *P. falciparum*, accounting for 45.4% of cases. This difference might be due to temperature and humidity, because Heben Arsi District is at a higher altitude and is more humid than Bahir Dar.

In the current study area, *P. vivax* accounted for 60% of cases, followed by *P. falciparum* at 23.6% and mixed infection at 16.4%. This result is quite different from the national prevalence of *P. falciparum* over *P. vivax* – 60% and 40%, respectively. The current study is in line with studies conducted in Dilla (19) and in Halaba (18), and East Shewa Zone, Oromia Region, where *P. vivax* is the most dominant species in the area. This might be due to similar climatological changes. In contrast, in a study reported in Arbaminch Hospital (24), the most prevalent species was *P. falciparum* (64.3%), followed by *P. vivax* (25%) and mixed infection (10.7%). Additionally, this result also contrasts with a study conducted in Ameya Woreda (south-west showa, Oromia rigion), and Berahel Woreda (Afar Region) (21, 26), which reported that the prevalence of *P. falciparum* is higher than *P. vivax*. Again, this might be due to differences in temperature and humidity.

The result of this study showed that malaria prevalence was higher in males than females. Of the infected patients 65.5% were male and 34.5% were female. This might be because males are engaged in more outdoor activities, exposing them to a greater risk of mosquito bites. This is in agreement with findings of studies conducted in Arsi Negele, Afdem and Sibu Sire districts, respectively (20,25). In contrast, Graves *et al*. (27) reported that there was no significant difference in the prevalence of malaria parasite between sexes.

Monthly income was significantly associated with the occurrence of malaria infection (28), suggesting that people with a lower income are characterized by poor access to health care facilities and lack of financial means to pay for vector control technologies, such as ITNs, IRS and antimalarial drugs. Poor people also typically reside in homes made from bad quality materials, which favor contact with the anopheles mosquito (29).

Selective IRS remains one of the key strategies of the National Malaria Control Program, though it is primarily used for epidemic prevention and response. IRS with insecticide has been shown to be highly effective as a malaria control measure in reducing the incidence of malaria infections and deaths in a number of settings (30). In the present study, there is a significant association between the prevalence of malaria and the use of IRS in the past five months. Similarly, the findings of a study by Upendo (31) support the assertion that IRS is associated with protection from malaria parasitemia.

The use of long-lasting insecticidal nets (LLINs) and ITNs aims to prevent contact between infective mosquitoes and humans. Hence, a difference was observed in malaria prevalence among ITNs users and non-users in this study. The prevalence of malaria among those who did not use ITNs was observed as high, compared to those who did use them. Several studies indicate that the use of ITNs significantly reduces the proportion of malaria morbidity and mortality (32). Using ITNs is considered one of the main protective factors against mosquito bites, hence reducing the prevalence of malaria (33). That said, some studies conducted in African countries have indicated that the use of ITNs does not produce a significant reduction in malaria morbidity and mortality (34).

In the current, study living near to a breeding site was identified as a risk factor. The highest prevalence rate was found among individuals living near breeding sites. This finding is echoed in a study conducted by Mushashu in Tanzania (31), who reported that close proximity of a house to breeding sites is an indicator of malaria transmission. A study conducted in southern Ethiopia also indicates that close dwelling proximity to malaria vector breeding sites is a risk factor for malaria (35). Finally, it was observed that the association between malaria positivity and houses with openings/holes in external walls was significant.

Conclusions

The present study indicates that malaria infections is still a public health problem in West Arsi Zone, Ethiopia, with *P. vivax* and *P. falciparum* infections the most common. Statistical analysis points to low income, the presence of holes/openings in walls, homes close to breeding sites, no use of IRS, and no use of bed nets as important predictors for malaria infection. As indicated in this study, in order to effectively reduce malaria infections, a multi-sectoral effort is needed. Preventive measures should include accessibility and improvement of health facilities, the treatment of infected patients, well-organized vector control, and community mobilization to reduce risk factors in Heben Arsi District, Ethiopia.

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Authors' contributions

AF, BD and MB conceived the project, designed the study protocol, collected and analyzed the data, and devised, drafted and reviewed the manuscript. All authors read and approved the final manuscript.

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